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The herpetofauna of the Baja California Peninsula and its adjacent islands, Mexico: composition, distribution, and conservation status

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***Abstract.*—The herpetofauna of the Baja California Peninsula, Mexico, consists of 172 species, including 18 anurans, three salamanders, 140 squamates, and 11 turtles. Among the 10 recognized geographic regions, the total number of herpetofaunal species ranges from a low of 27 in the Baja California Coniferous Forest Region to 84 in the Gulf Islands Region. The individual species occupy from one to 10 regions ($\bar{x}$ = 3.3). The Gulf Islands Region is of the greatest significant conservation importance, inasmuch as it contains the largest overall number of species (84), the largest number of single-region species (39), and the greatest number of peninsular endemics (50). A similarity dendrogram based on the Unweighted Pair Group Method with Arithmetic Averages (UPGMA) indicates that the two most closely related regions are the Central Gulf Coast Region and the Arid Tropical Region, while the most distantly related region is the Baja California Coniferous Forest Region. Among the distributional categories, the greatest number of species are the non-endemics (81 of 172, or 47.1%), followed by the peninsular endemics (77, 44.8%), and finally, the non-natives (14, 8.1%). The principal environmental threats to the herpetofauna of the Baja California Peninsula are land conversion and habitat loss, water diversion and overuse, invasive species, livestock grazing, illegal trade, off-road activities, infectious diseases, and climate change. We assessed the conservation status of the native species by employing the SEMARNAT, IUCN, and EVS systems. Of the 158 native species, 85 are included in NOM-059-SEMARNAT, 15 are in the IUCN Threatened categories, and 76 have high EVS values. Two Relative Herpetofaunal Priority (RHP) methods were used to identify the rank order significance of the 10 geographic regions, and the highest ranks for both methods were obtained for the Gulf Islands Region. Thirty protected areas are located in the Baja California Peninsula, and they comprise almost one-half of the total area. All but eight of the 158 native herpetofaunal species are represented within the system of protected areas. Few herpetofaunal surveys of the protected areas have been completed thus far, so this is a major conservation goal for the future.**

Keywords: Anurans, caudates, conservation status, physiographic regions, protected areas, protection recommendations, squamates, turtles

***Resumen.*—La herpetofauna de la Península de Baja California, México, consta de 172 especies, incluyendo 18 anuros, tres salamandras, 140 escamosos y 11 tortugas. Entre las 10 regiones geográficas reconocidas, el número total de especies de herpetofauna varía desde un mínimo de 27 en la Región del Bosque de Coníferas de Baja California hasta 84 en la Región de las Islas del Golfo. Las especies individuales ocupan de una a 10 regiones ($\bar{x}$ = 3.3). La Región de las Islas del Golfo es de gran importancia para la conservación, ya que contiene el mayor número total de especies (84), el mayor número de especies de una sola región (39) y el mayor número de endémicas peninsulares (50). Un dendrograma de similitud basado en el método de grupos de pares no ponderados con promedios aritméticos (UPGMA) indica que las dos regiones más estrechamente relacionadas son la Región de la Costa Central del Golfo y la Región Tropical Árida. La región más lejanamente relacionada es la Región del Bosque de Coníferas de Baja California. Entre las categorías de distribución el mayor número de especies son las no endémicas (81 de 172 o 47.1%), seguidas de las endémicas peninsulares (77 o 44.8%) y, por último, las no nativas (14 o 8.1%). Las principales amenazas ambientales para la herpetofauna de la península de Baja California son la conversión de tierras y la pérdida de hábitat, el desvío y uso excesivo**

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de agua, las especies invasoras, el pastoreo de ganado, el comercio ilegal, las actividades todoterreno, las enfermedades infecciosas y el cambio climático. Evaluamos el estado de conservación de las especies nativas empleando los sistemas de SEMARNAT, UICN y EVS. De las 158 especies nativas, 85 están incluidas en la NOM-059-SEMARNAT, 15 en las categorías Amenazadas de la UICN y 76 presentaron valores elevados de EVS. Mediante el uso de los dos métodos de prioridad herpetofaunística relativa (RHP) para identificar la importancia del orden de rango de las 10 regiones geográficas, se obtuvieron los dos rangos más altos para la región de las Islas del Golfo. Treinta áreas protegidas se encuentran en la Península de Baja California y comprenden casi la mitad del área total. Todas menos ocho de las 158 especies nativas de herpetofauna están representadas dentro del sistema de áreas protegidas. Se han completado pocos estudios de herpetofauna para las áreas protegidas, por lo que este es un objetivo de conservación importante para el futuro.

Palabras Claves: Anuros, caudados, escamosos, tortugas, regiones fisiográficas, áreas protegidas, estatus de conservación, recomendaciones de protección

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"...Baja California possesses a wild, intangible allure. An innate sense of adventure, heightened by a hint of danger and the unknown, beckons many explorers off the highway into Baja's harsh, poorly understood interior. Baja California's jagged, snow-covered peaks, volcanic badlands, parched deserts with relentless summer temperatures, and arid, uninhabited desert islands have been reluctant to give up their secrets. There is still much knowledge to be attained and many personal challenges to be met."

L. Lee Grismer (2002)

Introduction

One of the most distinctive features of the physiography of Mexico is the Baja California Peninsula, a finger-like extension of land flanked by small islands, which comprises two states of the 32 federal entities in the country, i.e., Baja California to the north and Baja California Sur to the south. These two states are separated from one another at latitude 28° N, just slightly to the north of Punta Eugenia, the northwestern point of the Península de Vizcaíno (Grismer 2002).

A succinct description of the physiography of the peninsula is provided in the now-classic volume on the herpetofauna authored by L. Lee Grismer (2002), in which the introduction (pg. 3) includes the following quote: "Today Baja California is a thin northwest to southeast-tending peninsula nearly 1,300 km long. It is situated between 32° 30' N latitude and 117° W longitude at its northwestern corner and [between] 23° N and 110° W at its southern tip. Its width ranges from approximately 240 km along the U.S.–Mexico border to less than 30 km at the Isthmus of La Paz. It is separated from the state of Sonora by the Río Colorado in the north and from the rest of Sonora and mainland Mexico by the Gulf of California, approximately 160 km wide. The area of Baja California is approximately 143,400 km^2, and its coastline is approximately 3,300 km long. Associated with the coastline are forty-five major islands, each at least 1.3 km^2 in area. Several smaller islands are also associated with Baja California, and an additional 10 or so major islands are principally associated with the Mexican states of Sonora and Sinaloa… [which are not considered in this paper]." More details on the physiography of this peninsula are provided in the section below entitled "Physiography and Climate."

With an area of 71,450 km^2, the state of Baja California is the 12th largest in Mexico and the 19th most densely populated. The corresponding data for the state of Baja California Sur are 73,909 km^2, the 9th largest, and the 32nd most densely populated (http://inegi.org.mx; accessed 8 June 2023).

Given the relative geographic isolation of the peninsula from the mainland of both the United States and Mexico, this area is expected to be characterized by a significant degree of endemism, especially since the mainland of the peninsula is flanked by a large number of variously sized islands. Also, given the limited range of these endemic species, they are expected to be subjected to the usual range of anthropogenic threats. Thus, the purpose of this paper is to examine these aspects as they relate to the interesting herpetofauna of this offset region of Mexico.

Materials and Methods

Our Taxonomic Position

In this paper, we follow the same taxonomic position as explained in previous works on other portions of Mesoamerica (Johnson et al. 2015; Mata-Silva et al. 2015; Terán-Juárez et al. 2016; Woolrich-Piña et al.

2016; Nevárez-de los Reyes et al. 2016; Cruz-Sáenz et al. 2017; Gonzalez-Sánchez et al. 2017; Woolrich-Piña et al. 2017; Lazcano et al. 2019; Ramírez-Bautista et al. 2020; Torres-Hernández et al. 2021; Cruz Elizalde et al. 2022). Johnson et al. (2015) can be consulted for a detailed statement of this position, with special reference to the subspecies concept.

System for Determining Distributional Status

The system developed by Alvarado-Díaz et al. (2013) for the herpetofauna of Michoacán was employed to ascertain the distributional status of members of the herpetofauna of the Baja California Peninsula, which consists of the following four categories: SE, endemic to the Baja California Peninsula; CE, endemic to Mexico; NE, not endemic to Mexico; and NN, non-native in Mexico.

Systems for Determining Conservation Status

The following three systems were used to determine the conservation status of the 158 native species of amphibians and reptiles in the Baja California Peninsula: SEMARNAT, IUCN, and EVS. The SEMARNAT system, established by the Secretaría de Medio Ambiente y Recursos Naturales, lists only the threatened species in the NOM 059-SEMARNAT-2010 (SEMARNAT 2010, 2019) under three categories: Endangered (P), Threatened (A), and Subject to Special Protection (Pr). For species not included on that list, we used the designation "No Status;" however, we acknowledge that the SEMARNAT list is not meant to include non-threatened species. For species included on that list for which taxonomy has changed, we maintain the conservation status of the previous taxonomic entity, following section six of NOM-059-SEMARNAT-2010 (SEMARANT 2010).

The IUCN system (https://www.iucnredlist.org) is utilized widely for assessing the conservation status of species on a global scale. The categories include Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), Data Deficient (DD), and Not Evaluated (NE). Collectively, the three categories of Critically Endangered, Endangered, and Vulnerable are termed the "threat categories" to distinguish them from the other six.

The EVS system was applied here for the 158 native species, following Wilson et al. (2013a,b). A re-evaluation was conducted because of taxonomic changes that have transpired since their original EVS values were reported, as well as regional differences in the degree of human persecution in mainland Mexico, as required for criterion C. The EVS measure was not designed for use with marine species (e.g., marine turtles and sea snakes), and is generally not applied to non-native species.

The Mexican Conservation Series

The Mexican Conservation Series (MCS) was initiated in 2013, with a study of the herpetofauna of Michoacán (Alvarado-Díaz et al. 2013) that was published as part of a set of five papers designated as the Special Mexico Issue in *Amphibian & Reptile Conservation*. The basic format of the entries in the MCS was established in that paper, i.e., examining the composition, physiographic distribution, and conservation status of the herpetofauna of a given Mexican state or group of states. Two years later, the MCS resumed with a paper on the herpetofauna of Oaxaca (Mata-Silva et al. 2015). That year, Johnson et al. (2015) authored a paper on the herpetofauna of Chiapas, and three entries in the MCS appeared the next year, covering Tamaulipas (Terán-Juárez et al. 2016), Nayarit (Woolrich-Piña et al. 2016), and Nuevo León (Nevárez-de los Reyes et al. 2016). The following year three additional entries appeared, covering Jalisco (Cruz-Sáenz et al. 2017), the Mexican Yucatan Peninsula (González-Sánchez et al. 2017), and Puebla (Woolrich-Piña et al. 2017). Subsequently, similar articles on Coahuila (Lazcano et al. 2019), Hidalgo (Ramírez-Bautista et al. 2020), and Veracruz (Torres-Hernández et al. 2021) were published. Last year, articles on Querétaro (Cruz Elizalde et al. 2022), Tabasco (Barragán-Vázquez et al. 2022), and Guanajuato (Leyte-Manrique et al. 2022) appeared. Thus, this article on the herpetofauna of the Baja California Peninsula is the 16th entry in this series.

Geography and Climate

Geographic Regions

The formation of the Baja California Peninsula in northwestern Mexico originated from a complex interaction of plate tectonics, which resulted in the formation of the Gulf of California. There are a large number of climatic variables and a varied topography along the peninsula (Shreve and Wiggins 1964; Grismer 2002; Hollingsworth et al. 2015). The interactions among these climatic and topographic variables have given rise to several distinct physiographic regions.

These characteristics also resulted in the formation of different phytogeographical regions, which can be distinguished by the different types of vegetation (Fig. 1). This situation is linked to the "double ecological polarity" that occurs on the peninsula (González-Abraham et al. 2010). First, a north-to-south gradient with a temperate climate in the northwest and a tropical climate in the south contains an extensive arid transition region between the two. Then, an east-to-west gradient has resulted from the combination of a mountain range distributed intermittently along the peninsula and the influence of two different marine water masses which are cold in the Pacific and warm in the Gulf of California (González-Abraham et al. 2010).

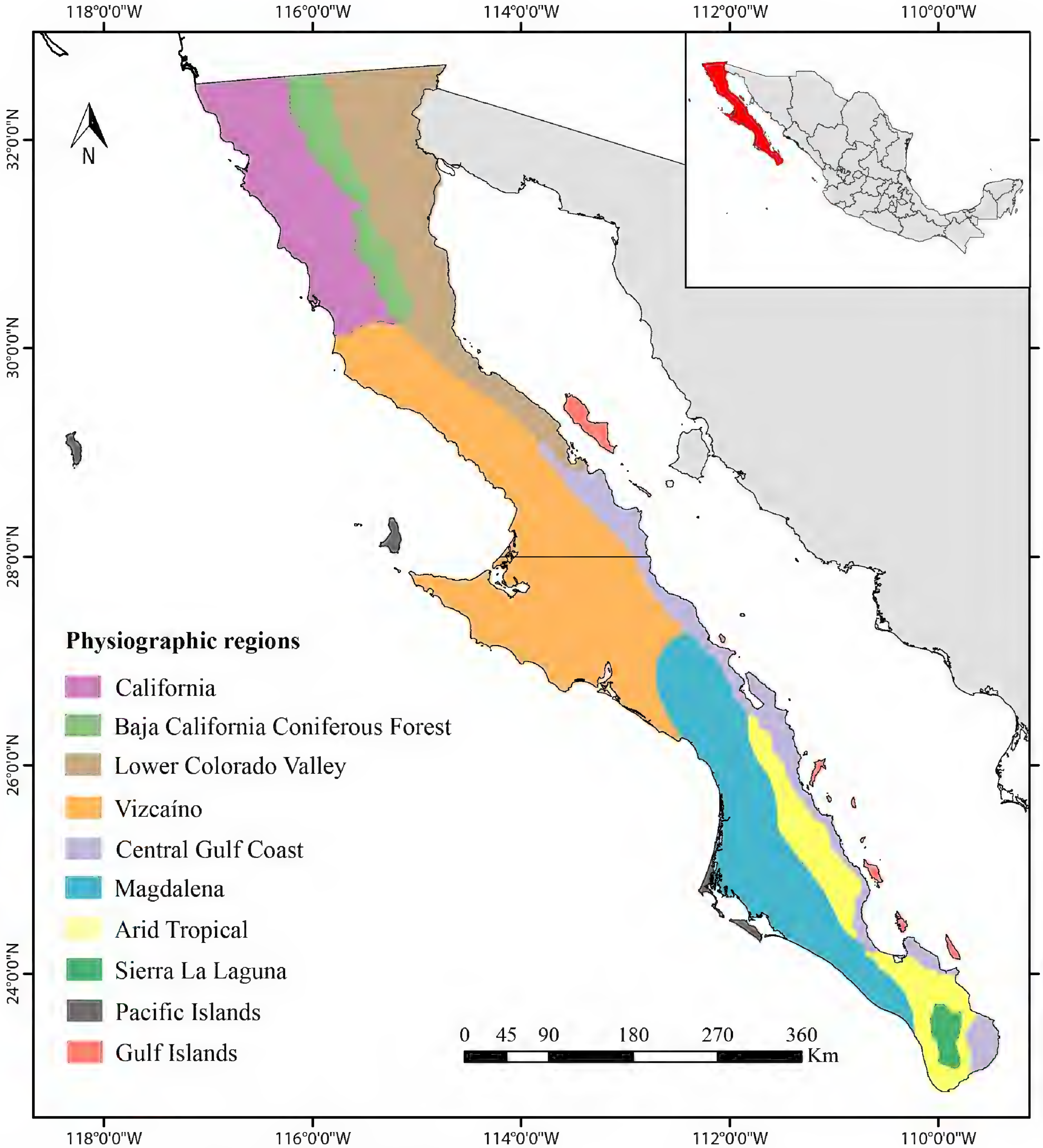


Fig. 1. Geographic regions of the Baja California Peninsula, Mexico.

The distribution of the herpetofauna of the Baja California Peninsula coincides with the phytogeographic regions (Grismer 1994, 2002). As indicators of the natural biotic provinces, they likely are influenced by the same environmental characteristics that limit the distributions of amphibians and reptiles (Grismer 2002). The following 10 regions have been identified: (1) California; (2) Coniferous Forest; (3) Lower Colorado Desert; (4) Vizcaíno Desert; (5) Central Gulf Coast Desert; (6) Magdalena; (7) Sierra La Laguna; (8) Arid Tropical; (9) Pacific Islands; and (10) Gulf Islands. Shreve and Wiggins (1964), Wiggins (1980), and Grismer (2002) defined these regions, and they are briefly described below.

California Region. Located in the northwestern quarter of the peninsula, this region (Fig. 2) extends 275 km from the border with the United States to the vicinity of El Rosario along the Pacific coast, where it slowly intergrades into the Vizcaíno Desert Region to the south (Hollingsworth et al. 2015). During the Pleistocene, the California Region likely extended farther southward onto the peninsula. However, successive periods of aridification replaced these communities with deserts that include remnants of the California Region flora (Van Devender 1990). Today, the California Region is confined to the northern state of Baja California. To the east, the region extends up the Sierra Juárez and Sierra San Pedro Mártir to an elevation of 2,000 m at the start

Fig. 2. California Region, as seen along the road to Sierra San Pedro Mártir, Baja California. *Photo by Jorge H. Valdez-Villavicencio.*

Fig. 3. Coniferous forest in Sierra San Pedro Mártir, Baja California. Picacho del Diablo (left), the highest peak on the peninsula (3,100 m), is seen in the background. *Photo by Felipe León.*

of the pine belt, with a mixed chaparral-coniferous forest zone found at elevations between 1,500 and 2,000 m (Delgadillo 2004). Farther to the east, the California Region comes into contact and intermixes with the Lower Colorado Desert in low-elevation passes between the mountains. Throughout this region, oak and willow forests primarily border the rivers that flow down from the mountains to the west, and thus dominate the riparian zones, and many of these rivers still flow year-round at mid to high elevations. Overall, the region is relatively cool for most of the year, due to the cold California Current that drives winds blowing off the Pacific Ocean waters, bathing the low elevations in morning fog (Hastings and Turner 1965; Markham 1972; Meigs 1966). Temperatures during the summer months average 20 to 25 °C, whereas winter temperatures average 10.0 to 12.5 °C. The precipitation comes from the tail end of Pacific winter storms that originate from the north, with a prominent decline in rain farther south (Humphrey 1974). This region is a southern extension of the coastal sage scrub and chaparral communities of southern California, which are dominated by sages (*Artemisia* and *Salvia*), buckwheat (*Eriogonum*), lilacs (*Ceanothus*), and chamise (*Adenostoma*).

Coniferous Forest Region. Prominent forests occur in both the Sierras Juárez and San Pedro Mártir (Fig. 3), which extend from the United States in the north and represent the southernmost segment of the Sierran

Fig. 4. Vegetation in the Lower Colorado Region at Valle del Borrego, Sierra San Felipe, Baja California. *Photo by Jorge H. Valdez-Villavicencio.*

Montane Conifer Forest (Pase 1982). These Peninsular Range mountains are confined to the northern state of Baja California and extend southward from the United States-Mexico border for approximately 300 km. Oriented in a north-south direction, they gradually rise along their western slopes, crest with peaks as high as 3,100 m, and rapidly descend to the desert floor with steep eastern escarpments. The mean monthly air temperatures range from -0.2 to 17 °C. This region has the most reliable precipitation on the peninsula, and receives more rainfall than any other area in Baja California (Hastings and Turner 1965). The majority of the precipitation falls during winter and spring in the form of snow at the higher elevations. Summer brings more variable thunderstorms, when the tropical air moving in a northwesterly direction is uplifted and cooled along the steep eastern slopes of the mountains (Humphrey 1974). The mountains contain extensive meadows that fill with water. The floristic composition of the region is relatively diverse, defined mainly by large shrubs and trees, which are dominated by Jeffrey Pines (*Pinus jeffreyi*), manzanitas (*Arctostaphylos*), oaks (*Quercus*), firs (*Abies*), aspens (*Populus*), and cedars (*Calocedrus*) (Garcillán et al. 2012).

Lower Colorado Desert Region. The Lower Colorado Desert (Fig. 4) is the largest subregion of the Sonoran Desert and extends across southeastern California, southwestern Arizona, northwestern Sonora, and northeastern Baja California (Shreve 1951). On the peninsula, this low-elevation desert extends from the Peninsular Ranges to the west and the Colorado River to the east. Confined to the northern state of Baja California, it extends for 450 km southward from the border of the United States to the vicinity of Bahía de los Ángeles, where it intergrades widely with the Gulf Coast Desert Region (Peinado et al. 1994). This region contains the late Miocene to Pliocene sedimentary deposits of the Colorado River and the receding waters of the Gulf of California, and is composed of broad expansive basins with elevations ranging from below sea level to 400 m (Spencer and Pearthree 2001). Along this region's northeastern boundary, the Río Colorado once provided a rich aquatic ecosystem in the middle of a harsh desert. Today, water no longer flows from the river to the Gulf of California due to its diversion for agricultural and urban use. The mean temperatures for July and August are above 32.5 °C, while the mean winter temperature is 12.5 °C (Markham 1972). Lying in the rainshadow of the Sierras Juárez and San Pedro Mártir, this region is the hottest and most barren desert on the peninsula, as it receives less than 5 cm of annual rainfall. Creosote Bush (*Larrea tridentata*), Burro Weed (*Ambrosia dumosa*), and Ocotillos (*Fouqueria splendens*) dominate the vegetation of this region, but it also contains other arid-adapted plants such as mesquites, agaves, palo verde, and various forms of cacti (González-Abraham et al. 2010).

Fig. 5. A view of the Vizcaíno Region at Sierra La Asamblea, Baja California, as seen from Transpeninsular Highway 1. *Photo by Jorge H. Valdez-Villavicencio.*

Fig. 6. South of Vizcaíno, Baja California Sur; fog is an essential component of this region. *Photo by Jorge H. Valdez-Villavicencio.*

Vizcaíno Desert Region. This region (Figs. 5–6) is located in the central portion of the peninsula, and extends from the California and Lower Colorado Desert Regions to Laguna San Ignacio. It is bordered by the Pacific Ocean to the west, but its eastern extent varies greatly and generally is limited by the Central Gulf Coast Desert Region that borders the Gulf of California. The southern portion of the Vizcaíno Desert Region is much flatter, with elevations just above sea level, whereas the northern portion consists of smaller mountain ranges, mesas, and dry washes that are no higher than 1,000 m (Bostic 1971). This region spans both Baja California and Baja California Sur. Many spring-fed oases are found throughout this region and support more mesic communities (Grismer and McGuire 1993). It also experiences a "fog type" temperate desert climate, with limited winter and summer precipitation (Meigs 1966). The mild climate is greatly influenced by prevailing westerly winds coming off the Pacific Ocean, which generate the conditions for heavy fog (Bostic

Fig. 7. Vegetation in the Central Gulf Coast Region, near San Basilio, Baja California Sur. *Photo by Alan Harper.*

Fig. 8. Vegetation in the Central Gulf Coast Region near Bahía Concepción, Baja California Sur. *Photo by Jorge H. Valdez-Villavicencio.*

1971). Rainfall occurs in the winter and averages only 5.5 cm. The mean air temperatures range between 23 and 28 °C during the summer, and 15° and 18 °C in winter (Markham 1972). Overall, this region often has overcast skies and a mild climate that receives little rain. In much of the region, the vegetation is open, stunted, widely spaced, and depauperate, because of continuous onshore winds from the Pacific Ocean (Grismer 2002). In areas protected from the winds, plant diversity increases sharply and the dominant plants include Cirios (*Fouquieria columnaris*), Baja California Tree Yucca (*Yucca valida*), Cardón (*Pachycereus pringlei*), Elephant Trees (*Pachycormus discolor*), mesquites (*Prosopis*), and agaves (*Agave*) (Garcillán et al. 2012).

Central Gulf Coast Desert Region. This long and narrow region (Figs. 7–9) lies along the eastern coast of the peninsula, extends southward from Bahía de los Ángeles to the Cape Region, and spans both states on the peninsula (Shreve and Wiggins 1964). Broad intermixing occurs between this region and the Lower Colorado Desert to the north (Peinado et al. 1994), whereas its boundaries to the west are marked by the uplift of the Peninsular Ranges. The elevation ranges from sea level to 800 m. This region is hot and arid, and receives nearly all of its precipitation during the summer and fall. Severe droughts occur in spring, a time when the mean precipitation is only 0.20 cm (Hastings and Turner 1965; Humphrey 1974). The majority of the Central Gulf Coast Desert rainfall originates from southern convectional storms, and appears as run-off from the bordering Peninsular Range. Occasionally, the region receives rainfall from hurricanes that originate

Fig. 9. Vegetation in the Central Gulf Coast Region, near San Basilio, Baja California Sur. *Photo by Jorge H. Valdez-Villavicencio.*

Fig. 10. View of the Magdalena Region at La Purisima, Baja California Sur. *Photo by Gerardo Marrón.*

in the southern tropical waters and track northward. Despite periods of severe drought, the annual mean rainfall can reach 16.8 cm (Hastings and Turner 1965) when there has been an active hurricane season. The mean temperatures for the warmest summer months are above 30 °C, whereas the mean winter temperatures fall to around 15 °C (Markham 1972). Arid-adapted plants that include Elephant Trees (*P. discolor*), Palo Blanco (*Lysiloma candidum*), lomboy (*Jatropha*), Palo Adan (*Fouquieria diguettii*), and various forms of cacti, including large columnar forms, characterize the vegetation. Some mangroves are also present in the southern part of this region, where Black Mangrove (*Avicennia germinans*) and White Mangrove (*Laguncularia racemosa*) are the most predominant species (González-Zamorano et al. 2011; Garcillán et al. 2012).

Magdalena Region. This region (Figs. 10–12) extends from Laguna San Ignacio to the Cape Region, along the southwestern coast of the peninsula, and receives the Pacific drainages of the Sierra Guadalupe and Sierra La Giganta. Its eastern border is defined by the uplift of the Peninsular Ranges and its contact with the Central Gulf Coast Desert. This region is confined to Baja California Sur, and is composed of a rugged mountainous region along the eastern border and a flat open plain along the western portion. The mountains contain volcanic badlands interspersed with spring-fed oases (Grismer and McGuire 1993), whereas the western plains consist of sandy fluvial deposits that rely on run-off from the mountains. The elevation in this region ranges from sea level to 1,100 m. The coastal areas receive cool morning fog, but precipitation is low and unpredictable. The mean annual rainfall can reach 12.5 cm (Hastings and Turner

Fig. 11. View of the Madgalena Region at Los Burros, Baja California Sur. *Photo by Bradford Hollingsworth.*

Fig. 12. View of the Magdalena Region at 3.4 km NW Puerto Cancún, Baja California Sur. *Photo by Gerardo Marrón.*

1965). The mean temperatures for the warmest summer months are above 29 °C, whereas the mean winter temperatures are only 17 °C (Markham 1972). Creosote Bush (*Larrea tridentata*), Elephant Trees (*Bursera*), Peninsular Palo Verde (*Parkinsonia florida*), and columnar and various other types of cacti, mesquites, and palms (*Washingtonia*) in oases dominate the vegetation (Garcillán et al. 2012).

Sierra La Laguna Region. The Sierra La Laguna Region (Fig. 13) is located at the southern tip of the Baja California Peninsula, within the Cape Region, and contains dense forests at the higher elevations. Formed by granitic and intrusive rock, these mountains rise to an elevation of 2,200 m, and have undergone a long history of isolation (Garcillán et al. 2012). Confined to the state of Baja California Sur, this region extends from above 800 m and receives its moisture from summer convectional storms and passing hurricanes. The mean annual rainfall can reach 29.6 cm (Hastings and Turner 1965). Due to a wide range in elevation, the temperatures vary greatly. At the higher elevations, the mean temperatures for the warmest summer months are above 18 °C, whereas the mean winter temperatures are only 8 °C (Markham 1972). The vegetation contains numerous endemics, and the mid-elevation slopes are covered with oak woodlands (*Quercus tuberculata*; *Q. brandegeei*), while the upper

Fig. 13. A view of Sierra La Laguna, the highest mountain range in Baja California Sur, as seen from Segundo Valle. *Photo by Jorge H. Valdez-Villavicencio.*

Fig. 14. Arid Tropical Region vegetation is evident along Transpeninsular Highway 1, south of La Paz between San Antonio and San Bartolo, Baja California Sur. *Photo by Jorge H. Valdez-Villavicencio.*

elevations are covered with pine-oak woodlands (*Q. devia* and *Pinus lagunae*), Peninsular Madrone (*Arbutus peninsularis*), and Belding Bear-grass (*Nolina beldingii*) (Garcillán et al. 2012).

Arid Tropical Region. This region (Fig. 14) is comprised of the Sierra La Giganta, located along the central uplift of the southern peninsula and the lowlands of the Cape Region, and extends from south of the Isthmus of La Paz to the southern terminus of the peninsula. In the Cape Region, two well-differentiated landscapes of mountain foothills and coastal alluvial plains characterize this region (Garcillán et al. 2012). The foothills extend from 500 to 1,000 m in elevation and intermix with the Sierra La Laguna Region, whereas the alluvial plains are found from sea level to 500 m. This region is confined to the state of Baja California Sur. The mean annual rainfall can reach 29.2 cm (Hastings and Turner 1965), and usually occurs in late summer and early fall. This region is hot, with mean temperatures for the warmest summer months above 28.8 °C (Markham 1972). The vegetation is composed of tropical dry forests in the foothills that remain leafless in the dry season, but rebound with the late summer rains. The vegetation includes a variety of woody trees like Palo Blanco (*Lysiloma candidum*), Mauto (*L. divaricatum*), Plumeria (*Plumeria rubra),* and Cardón Barbón (*Pachycereus pecten-aboriginum*). The coastal lowlands are composed of a fleshy-stemmed shrubland that includes elephant trees (*Bursera*), Ashy

Fig. 15. A view from the southern end of the Todos Santos Sur island in which the northern part of the south island and the Todos Santos Norte island, including its lighthouse, are visible. *Photo by Jorge H. Valdez-Villavicencio.*

Fig. 16. Islas los Coronado (four islands), Baja California. View from Coronado Sur, of Coronado Norte, Pilón de Azúcar, and Coronado Medio. *Photo by Jorge H. Valdez-Villavicencio.*

Limberbush (*Jatropha cinerea*), figs (*Ficus brandegeei*), and succulents (Garcillán et al. 2012).

The Pacific Islands. Along the west coast of the peninsula, the Pacific Ocean is dominated by the California Current System, which extends from Alaska to northern Baja California, but seasonally extends southward to the tip of the peninsula (Hickey 1979; Badan-Dangon et al. 1989). The California Current consists of a year-round equatorward surface flow that brings cool water down the coastal waters of the peninsula (Kurczyn et al. 2019). On the contrary, the coast of mainland Mexico to the south is exposed to warmer waters from the Equatorial Countercurrent that feeds the Costa Rica Coastal Current flowing poleward, bringing warm counterflows northward along the peninsula (Badan-Dangon et al. 1989). During El Niño years, the poleward surface currents intensify and bring warmer water farther north, along with some marine reptiles (Grismer 2002). The west coast of the peninsula also contains extensive lagoons and bays which provide important warm-water shelters that are preferred by some sea turtles (Senko et al. 2010).

The Pacific Islands (Figs. 15–17) extend along much of the length of the peninsula, from the Islas Coronado offshore from Tijuana, which are located just south of the

Fig. 17. Todos Santos Sur Island is almost entirely invaded by different species of dense grasses (e.g., *Bromus* and *Avena*) and ice plants, which displace the native vegetation. The invasion of introduced grasses and ice plants (*Mesembryanthemum crystallinum*) occurs throughout the peninsula. *Photo by Jorge H. Valdez-Villavicencio.*

border between California in the United States and Baja California in Mexico, to Isla Creciente, the southernmost island of the insular group, which lies off the Magdalena region of the southwestern peninsula. As noted by Grismer (2002: 9), "the islands of the Pacific coast of Baja California are all landbridge in origin, except for the Islas San Benito, which are oceanic…The largest and most environmentally diverse Pacific island is Isla Cedros, which reaches nearly 1,200 m in elevation. The remaining islands are generally low, small, and rocky, with the notable exception of Isla Creciente, the long, narrow sandbar enclosing the southern end of Bahía Magdalena."

The Gulf Islands. The Gulf of California is a 1,400 km long semi-enclosed sea that extends from a depth of more than 3,000 m at the southern entrance to only 200 m at its enclosed end at the Colorado River outlet (Álvarez-Borrego 2002; Lavin and Marinone 2003). The entrance to the Gulf of California is exposed to warmer waters from the poleward flowing Costa Rica Coastal Current (Badan-Dangon et al. 1989). The current in the sea flows northward along the mainland coast and southward down the peninsula during the summer months, and then reverses direction during the winter (Álvarez-Borrego 2002). The mean temperatures in the northern portion of the sea are 8.2 °C in December and 32.6 °C in August (Álvarez-Borrego 2002). Numerous islands and bays (Figs. 18–23) provide a diversity of coastal microhabitats that are favorable to marine reptiles, including sandy beaches, mangrove forests, reefs, and shelters, whereas deep water pelagic conditions exist in the southern Gulf of California,

Fig. 18. View of the shore of Isla Carmen located in the southern Gulf of California and protected within Parque Nacional Bahía de Loreto. This island is part of the Bahía de Loreto National Park. *Photo by Bradford D. Hollingsworth.*

Fig. 19. View of Puerto Balandra, Isla Carmen, a small bay on the northwestern side of the island, representing the typical arid habitat found within the Gulf Island Region, and home to the single-region endemics *Sauromalus slevini* and *Aspidoscelis carmenensis*. *Photo by Bradford D. Hollingsworth.*

which support open-water species (Santamaría-del-Angel et al. 1994; Lavin and Marinone 2003).

Climate

Temperature. The monthly minimum, mean, and maximum temperatures for one representative locality from each of the 10 geographic regions we recognize in the Baja California Peninsula are given in Table 1. The elevations for these localities range from 3 m at Isla Cedros in the Pacific Islands to 1,580 m at Laguna Hanson in the Baja California Coniferous Forest.

The mean annual temperature (MAT) is highest at Loreto (elevation 20 m) in the Central Gulf Coast Region and lowest at Laguna Hanson (elevation 1,580 m) in the Baja California Coniferous Forest Region.

Fig. 20. View of the uninhabited Isla San Francisco, a small island located in the southern Gulf of California and home to the single-region endemics *Aspidoscelis celeripes* and *A. franciscensis. Photo by Bradford D. Hollingsworth.*

Fig. 21. View of Isla Carmen, Gulf of California, protected within Parque Nacional Bahía de Loreto. *Photo by Bradford D. Hollingsworth.*

Fig. 22. View of the uninhabited Isla Santa Catalina, also known as Catalana Island, located in the Gulf of California off the coast of Loreto, Baja California Sur, which is protected within Parque Nacional Bahía de Loreto and home to some of the most vulnerable species, including nine single-region endemics. *Photo by Bradford D. Hollingsworth.*

Fig. 23. Aerial view of the uninhabited Isla Danzante, which is protected within Parque Nacional Bahía de Loreto, with cliffs up to 150 m, representing the rugged topography typical of islands in the Gulf Island Region. *Photo by Bradford D. Hollingsworth.*

Among the 10 geographic regions of the Baja California Peninsula, the minimum annual temperatures range from 2.2 °C at Laguna Hanson in the Baja California Coniferous Forest to 17.8 °C in three localities: Santo Tomas (180 m) in the California Region, Loreto (20 m) in the Central Gulf Coast Region, and El Barril (50 m) in the Gulf Islands Region.

The minimum monthly temperatures peak in either July (Baja California Coniferous Forest Region), August (California Region, Lower Colorado Valley Region, Vizcaíno Region, Central Gulf Coast Region, Magdalena Region, Arid Tropical Region, Sierra La Laguna Region, and Gulf Islands Region), or August and September (Pacific Islands Region). The minimum monthly temperatures reach their lowest levels in either January (California, Lower Colorado Valley, Baja California Coniferous Forest, Central Gulf Coast, Magdalena, Arid Tropical, Sierra La Laguna, Pacific Islands, and Gulf Islands regions) or December and January (Vizcaíno region).

The maximum monthly temperatures are highest in either July (Lower Colorado Valley and Baja California Coniferous Forest regions), August (California, Vizcaíno, Central Gulf Coast, Magdalena, Arid Tropical, Sierra La Laguna, and Gulf Islands regions), or September (Pacific Islands region), and are lowest in either January (California, Lower Colorado Valley, Baja California Coniferous Forest, Central Gulf Coast, Magdalena, Arid Tropical, Sierra La Laguna, Pacific Islands, and Gulf Islands regions) or December and January (Vizcaíno region).

Precipitation. The patterns of precipitation in the Baja California Peninsula are peculiar compared to those of other regions in Mexico. Whereas the rainy and dry seasons are confined to specific sets of six months during the year in most areas of Mexico, the rainy season in the Baja California Peninsula is comprised of no more than three or four months. In addition, the months involved are not the same throughout the Peninsula, and are not necessarily sequential.

Table 2 provides the precipitation data for 10 localities within each of the 10 geographic regions that we recognize in the peninsula, including the Pacific and Gulf islands. The rainy season extends for three months in the Lower Colorado Valley, the Baja California Coniferous Forest, the Central Gulf Coast, the Magdalena Region, and the Pacific Islands; while it extends for four months in the other five regions. The months involved in the 3-month regions are August through October (in the Lower Colorado Valley, the Central Gulf Coast, and the Magdalena Region), January through March (in the Baja California Coniferous Forest), and December through February (in the Pacific Islands). Those included in the 4-month regions are December through March (in the California Region), September through December (in the Vizcaíno Region), August through November (in the Arid Tropical Region), July through October (in the Sierra La Laguna Region), and August through October plus December (in the Gulf Islands).

The annual precipitation ranges from 52.2 mm in the Pacific Islands to 581.8 mm in the Sierra La Laguna Region. The mean annual precipitation for the 10 regions is 211.3 mm. The six annual precipitation values lying below this mean are for the Lower Colorado Valley (60.8 mm), the Vizcaíno Region (86.0 mm), the Central Gulf Coast Region (160.0 mm), the Magdalena Region (127.0 mm), the Pacific Islands (52.2 mm), and the Gulf Islands

Table 1. Monthly minimum, mean (in parentheses), maximum, and annual temperature data (in °C) for the 10 geographic regions of the Baja California Peninsula, Mexico. Localities in each region and their elevations are as follows: California, Santo Tomas (180 m); Lower Colorado Valley, El Mayor (15 m); Baja California Coniferous Forest, Laguna Hanson (1,580 m); Vizcaíno, Benito Juarez (55 m); Central Gulf Coast, Loreto (20 m); Magdalena, La Purisima (95 m); Arid Tropical, San José del Cabo (20 m); Sierra La Laguna, San Vicente de la Sierra (650 m); Pacific Islands, Isla Cedros (3 m); and Gulf Islands, El Barril (50 m). Data were taken from Servicio Meteorológico Nacional at https://smn.conagua.gob.mx (accessed 18 July 2022).

Physiographic region	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
California	3.5 (12.2) 20.9	4.6 (13.0) 21.3	5.7 (14.0) 22.3	7.2 (16.0) 24.7	9.5 (18.3) 27.1	11.2 (20.9) 30.6	13.6 (24.1) 34.6	14.3 (24.6) 34.8	13.3 (23.6) 34.0	9.5 (19.5) 29.5	5.6 (15.2) 24.8	3.3 (12.4) 21.5	17.8 (17.8) 27.2
Lower Colorado Valley	4.9 (12.6) 20.2	6.6 (14.1) 21.6	8.5 (16.3) 24.2	10.4 (18.7) 27	13 (23.8) 34.6	16.1 (28.6) 41	19.3 (31.3) 43.4	19.8 (31.3) 42.9	17.5 (28.6) 39.6	13.2 (23) 32.9	8.8 (17.1) 25.5	5.2 (12.8) 20.4	11.9 (21.5) 31.1
Baja California Coniferous Forest	-2.7 (4.5) 11.7	-2.3 (5.4) 13.1	-1.6 (5.7) 12.9	0 (8.0) 16	2.7 (11.5) 20.3	5.6 (15.1) 24.6	9.5 (19.0) 28.4	9.1 (18.5) 27.9	7.1 (16.2) 25.4	2.2 (11.1) 20	-0.8 (7.4) 15.7	-2.4 (5.4) 13.4	2.2 (10.7) 19.1
Vizcaíno	6.4 (16.4) 26.4	7.3 (17.2) 27.1	8.8 (18.3) 27.9	10.2 (19.5) 28.8	12.0 (20.6) 29.2	13.5 (22.1) 30.7	16.1 (25.1) 34.2	17.5 (26.6) 35.7	17.0 (25.9) 34.9	13.6 (22.9) 32.2	9.5 (19.5) 29.4	6.9 (16.7) 26.4	11.6 (20.9) 30.2
Central Gulf Coast	11.0 (17.2) 23.5	11.2 (17.9) 24.6	12.4 (19.3) 26.3	14.6 (21.8) 28.9	17.6 (24.7) 31.8	21.8 (28.2) 34.6	25.6 (30.7) 35.8	26.0 (31.1) 36.1	24.8 (30.2) 35.5	20.7 (26.9) 33.1	15.8 (22.0) 28.3	12.2 (18.3) 24.4	17.8 (24.0) 30.2
Magdalena	8.6 (17.7) 26.8	9.0 (18.5) 28.0	9.8 (19.5) 29.2	10.6 (20.7) 30.7	12.3 (22.0) 31.8	15.2 (24.7) 34.2	20.1 (28.6) 37.2	21.5 (29.6) 37.7	20.8 (28.9) 37.1	15.9 (25.2) 34.4	11.7 (21.2) 30.7	9.5 (18.4) 27.3	13.8 (22.9) 32.1
Arid Tropical	12.0 (18.9) 25.8	12.0 (19.2) 26.4	12.8 (20.1) 27.4	14.8 (21.9) 29.1	17.1 (24.0) 30.9	20.5 (26.5) 32.6	23.3 (28.5) 33.8	23.8 (28.9) 33.9	23.0 (28.2) 33.4	20.1 (26.2) 32.3	16.3 (23.2) 30.1	13.4 (20.2) 26.9	17.4 (23.8) 30.2
Sierra La Laguna	6.4 (15.7) 24.9	7.2 (16.5) 25.8	8.4 (17.7) 27.1	10.9 (21.0) 31.1	13.9 (23.6) 33.3	16.5 (25.8) 35.2	19.4 (27.9) 36.4	19.8 (27.9) 36.6	18.1 (26.2) 34.4	16.0 (24.6) 33.2	11.7 (20.7) 29.7	8.2 (17.4) 26.6	13.0 (22.1) 31.1
Pacific Islands	14.3 (18.6) 22.8	14.7 (19.1) 23.4	14.7 (19.2) 23.6	15.7 (20.5) 25.3	16.3 (21.0) 25.7	17.3 (21.7) 26.2	19.4 (24.0) 28.6	20.5 (24.9) 29.4	20.5 (25.0) 29.5	19.1 (23.8) 28.6	17.0 (21.4) 25.7	15.1 (19.2) 23.2	17.1 (21.5) 26.0
Gulf Islands	10.8 (16.4) 21.9	11.5 (17.3) 23.1	12.8 (18.8) 24.7	15.0 (21.0) 27.1	17.7 (23.6) 29.5	22.0 (27.7) 33.4	26.0 (30.7) 35.4	26.3 (30.8) 35.4	24.8 (29.8) 34.7	20.1 (25.8) 31.4	14.8 (20.6) 26.4	11.4 (17.0) 22.6	17.8 (23.3) 28.8

(91.6 mm). The four values lying above this mean are for the California Region (274.9 mm), the Baja California Coniferous Forest (390.9 mm), the Arid Tropical Region (288.0 mm), and the Sierra La Laguna Region (581.8 mm).

The percentages of annual precipitation that occur during the rainy season are as follows:

- California Region: 210.8/274.9 = 76.7% (4-month rainy season)
- Lower California Valley: 27.4/60.8 = 45.1% (3-month)
- Baja California Coniferous Forest: 176.4/390.9 = 45.1% (3-month)
- Vizcaíno Region: 47.8/86.0 = 55.6% (4-month)
- Central Gulf Coast Region: 111.9/160.0 = 69.9% (3-month)
- Magdalena Region: 66.1/127.0 = 52.0% (3-month)
- Arid Tropical Region: 209.0/288.0 = 72.6% (4-month)
- Sierra La Laguna Region: 519.9/581.8 = 89.4% (4-month)
- Pacific Islands: 30.0/52.2 =57.5% (3-month)
- Gulf Islands: 67.4/91.6 = 73.6% (4-month)

The range of percentages for the 3-month rainy seasons is 45.1–69.9% while it is 55.6–89.4% for the 4-month rainy seasons.

Composition of the Herpetofauna

Families

The members of the native and non-native herpetofauna of the Baja California Peninsula and its adjacent islands (hereinafter "the Baja California Peninsula" or simply "the peninsula") are assigned to 32 families, including five families of anurans, one of salamanders, 20 of squamates, and six of turtles (Table 3). The total comprises 51.6% of the 62 families of native and non-native species found in Mexico. No crocodylian or caecilian families are represented on the peninsula. Of the six amphibian families represented on the peninsula, 85.7% of the 21 species (Tables 4 and 5) are placed in the families Bufonidae (six species), Hylidae (three), Ranidae (six), and Plethodontidae (three). Among the 26 reptilian families, 122 of the 151 species (80.8%) are allocated in the families Crotaphytidae (five species), Iguanidae (nine), Phrynosomatidae (30), Phyllodactylidae (five),

Table 2. Monthly and annual precipitation data (in mm) for the 10 geographic regions of the Baja California Peninsula, Mexico. Localities in each region and their elevations are as follows: California, Santo Tomas (180 m); Lower Colorado Valley, El Mayor (15 m); Baja California Coniferous Forest, Laguna Hanson (1,580 m); Vizcaíno, Benito Juarez (55 m); Central Gulf Coast, Loreto (20 m); Magdalena, La Purisima (95 m); Arid Tropical, San José del Cabo (20 m); Sierra La Laguna, San Vicente de la Sierra (650 m); Pacific Islands, Isla Cedros (3 m); and Gulf Islands, El Barril (50 m). Data were taken from Servicio Meteorológico Nacional at https://smn.conagua.gob.mx (accessed 18 July 2022). Shaded areas indicate the months of the rainy season in each region.

Physiographic region	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
California	60.3	60.1	51.8	19.4	2.6	0.3	1.4	2.5	3.6	9.8	24.5	38.6	274.9
Lower Colorado Valley	6.0	6.8	5.0	2.2	0.0	0.3	3.2	9.4	10.3	7.7	3.1	6.8	60.8
Baja California Coniferous Forest	51.1	57.0	68.3	22.9	3.9	0.5	33.8	39.9	21.5	17.8	38.1	36.1	390.9
Vizcaíno	8.9	12.4	7.0	0.7	0.2	0.0	3.0	6.0	9.7	6.5	8.6	23.0	86.0
Central Gulf Coast	12.3	5.0	1.4	0.0	0.2	0.4	7.1	36.6	56.6	18.7	7.4	14.3	160.0
Magdalena	12.3	8.4	3.5	0.6	0.2	0.1	8.8	26.9	27.1	12.1	7.3	19.7	127.0
Arid Tropical	13.1	5.3	1.3	1.0	0.3	0.9	20.5	53.6	112.5	42.9	25.2	11.4	288.0
Sierra La Laguna	14.6	11.4	2.3	0.0	0.0	3.1	39.3	155.9	303.7	21.0	16.3	14.2	581.8
Pacific Islands	9.5	11.2	4.9	1.7	0.6	0.1	0.2	0.7	3.1	6.1	4.8	9.3	52.2
Gulf Islands	6.1	6.1	2.1	0.2	0.2	0.4	5.2	18.8	25.9	9.5	3.4	13.7	91.6

Teiidae (13), Xantusiidae (four), Colubridae (29), Dipsadidae (seven), Natricidae (four), Viperidae (12), and Cheloniidae (four).

Genera

Representatives of 64 herpetofaunal genera have been recorded from the Baja California Peninsula, including nine genera of anurans, three of caudates, 42 of squamates, and 10 of turtles (Table 3). These 64 taxa comprise 30.0% of the 213 genera that occur in Mexico (J. Johnson, unpub. data, 27 May 2023). Among the amphibians, the largest numbers of species in Baja California are in the genera *Anaxyrus* (five species) and *Lithobates* (four); and among reptiles the largest numbers are in the genera *Elgaria* (five), *Sauromalus* (five), *Petrosaurus* (four), *Phrynosoma* (five), *Sceloporus* (10), *Urosaurus* (four), *Uta* (five), *Phyllodactylus* (five), *Aspidoscelis* (13), *Xantusia* (four), *Lampropeltis* (four), *Masticophis* (five), *Sonora* (eight), *Hypsiglena* (six), *Thamnophis* (four), and *Crotalus* (12).

Species

The herpetofauna of the Baja California Peninsula consists of 172 species, including 18 anurans, three salamanders, 140 squamates, and 11 turtles (Table 3). The current numbers of native species in these four groups in Mexico are 272, 161, 913, and 51, respectively (J. Johnson, unpub. data, 27 May 2023). The 172 herpetofaunal species known from the Baja California Peninsula represent 12.3% of the 1,397 species of anurans, salamanders, squamates, and turtles in the entire country (J. Johnson, unpub. data, 27 May 2023). The only Mexican state that shares a border with the peninsula is Sonora, and that border is limited in extent. Rorabaugh and Lemos Espinal (2016) reported the number of herpetofaunal species in Sonora as 196, which is 1.1 times the size of the herpetofauna of the peninsula. This proportion is similar to the relative areas of the two regions. The surface area of Sonora is 185,430 km^2 (Rorabaugh and Lemos Espinal 2016) and that of the Baja California Peninsula is approximately 143,400 km^2; thus, Sonora is about 1.3 times the size of the entire peninsula. Therefore, the area/species richness ratios are 828.9 for the peninsula and 946.1 for Sonora.

Fourteen non-native species comprise 8.1% of total herpetofauna (172 species) of the Baja California Peninsula, and each of the two states contains nine non-native species and share four species. This is the highest number so far in our series of Mexican state herpetofaunas, with an average of four non-natives. Of the 14 non-native species in the Peninsula, five are amphibians, and nine are reptiles (three geckos, two iguanas, one snake, and three turtles), including two species that were listed among the 100 worst invasive alien species (*Lithobates catesbeianus* and *Trachemys scripta*) (Lowe et al. 2000).

Table 3. Composition of the native and non-native herpetofauna of the Baja California Peninsula and its adjacent islands, Mexico.

Order	Families	Genera	Species
Anura	5	9	18
Caudata	1	3	3
Subtotal	**6**	**12**	**21**
Squamata	20	42	140
Testudines	6	10	11
Subtotal	**26**	**52**	**151**
Total	**32**	**64**	**172**

Patterns of Geographic Distribution

We adopted the principal features of the scheme of geographic regions used by Grismer (2002). However, we departed from this system to some extent, in that we recognize the insular regions as separate from the peninsular regions (Table 4). Thus, we recognize eight regions on the peninsula and two regions among the islands (Pacific and Gulf). The distributional data for the 172 species are tabulated in Table 4, and summarized in Table 5.

The total number of species in each of the 10 regions (Table 5) ranges from 27 in the Baja California Coniferous Forest Region (BCCFR) to 84 in the Gulf Islands Region (GIR). The average number of regional species is 56.9. The sizes of the herpetofaunas in six of the regions (CR, LCVR, VR, CGCR, ATR, and GIR) are above this average value, and in four (BCCFR, MR, SLLR, and PIR) they are below it. The respective sizes of the regional herpetofaunas do not appear to be related to the relative sizes of the regions themselves, especially since the largest herpetofauna is found on the islands of the Gulf Region. We will examine this issue in greater detail after we present the subsequent analyses.

The amphibian fauna of the peninsula is comprised of only 21 species (18 anurans and three salamanders), or 12.2% of the total of 172 species. Thus, 87.8% of the total are reptiles. Relatively few of the 151 species of reptiles are turtles, i.e., 11 species (7.3%). Therefore, most of the herpetofaunal species found in the peninsula are squamates, viz., 140 species, or 81.4% of the total of 172. This result is reasonable, given that the general climate of the peninsula is arid and that much of the diversity of the herpetofauna is insular in distribution (see below). Of the 140 squamate species, 83 (59.3%) are lizards and 57 (40.7%) are snakes. Consequently, the peninsula is a hotspot for lizards, since the 83 species comprise 48.3% of the total herpetofauna.

The proportion of the total herpetofauna of 172 species found in each of the 10 regions ranges from 15.9% (27 species in the BCCFR) to 48.8% (84 in the GIR), which indicates the limited extent of species distributions on the peninsula.

The members of the peninsular herpetofauna occur in from one to 10 regions as follows: one region (78 of 172 species, 45.3%); two regions (16, 9.3%); three (17, 9.9%); four (10, 5.8%); five (13, 7.6%); six (seven, 4.1%); seven (six, 3.5%); eight (12, 7.0%); nine (7, 4.1%), and 10 (six, 3.5%). The mean regional occupancy is 3.3. This figure lies within the range of 1.6 to 3.7 for the other states dealt with thus far in the MCS (Alvarado-Díaz et al. 2013; Mata-Silva et al. 2015: Johnson et al. 2015; Terán-Juárez et al. 2016; Woolrich-Piña et al. 2016; Nevárez-de los Reyes et al. 2016; Cruz-Sáenz et al. 2017; González-Sánchez et al. 2017; Lazcano et al. 2019; Ramírez-Bautista et al. 2020; Torres-Hernández et al. 2021; Cruz-Elizalde et al. 2022). Of the 172 species known from the peninsula, a relatively large proportion (45.3%) is confined to a single region, which is highly significant from a conservation perspective (see below). The number of single-region species ranges from one (in the MR) to 39 (in the GIR).

The 39 single-region species in the GIR are as follows, with species endemic to the peninsula indicated by double asterisks, and non-natives indicated by triple asterisks:

*Crotaphytus insularis***
*Coleonyx gypsicolus***
*Dipsosaurus catalinensis***
*Sauromalus hispidus***
*Sauromalus klauberi***
*Sauromalus slevini***
*Sauromalus varius****
*Petrosaurus slevini***
*Sceloporus angustus***
*Sceloporus grandaevus***
*Sceloporus lineatulus***
*Uta encantadae***
*Uta lowei***
*Uta squamata***
*Uta tumidarostra***
*Phyllodactylus bugastrolepis***
*Phyllodactylus partidus***
*Aspidoscelis canus***
*Aspidoscelis carmenensis***
*Aspidoscelis catalinensis***
*Aspidoscelis celeripes***
*Aspidoscelis ceralbensis***
*Aspidoscelis danheimae***
*Aspidoscelis espiritensis***
*Aspidoscelis franciscensis***
*Aspidoscelis pictus***
*Lampropeltis catalinensis***
*Masticophis barbouri***
*Rhinocheilus etheridgei***

Table 4. Distribution of amphibians and reptiles in the Baja California Peninsula and its adjacent islands, Mexico, by geographic province. Abbreviations: CR = California Region; LCVR = Lower Colorado Valley Region; BCCFR = Baja California Coniferous Forest Region; VR = Vizcaíno Region; CGCR = Central Gulf Coast Region; MR = Magdalena Region; ATR = Arid Tropical Region; SLLR = Sierra La Laguna Region; PIR = Pacific Islands Region; and GIR = Gulf Islands Region. * = species endemic to Mexico; ** = species endemic to Baja California; *** = non-native.

Taxon	Geographic regions of the Peninsula of Baja California and its adjacent islands										Number of regions occupied
	CR	LCVR	BCCFR	VR	CGCR	MR	ATR	SLLR	PIR	GIR	
Anura (18 species)											
Bufonidae (6 species)											
Anaxyrus boreas	+	+	+	+							4
Anaxyrus californicus	+										1
Anaxyrus cognatus		+									1
Anaxyrus punctatus		+		+	+	+	+	+	+	+	8
Anaxyrus woodhousii		+									1
Incilius alvarius		+									1
Hylidae (3 species)											
Pseudacris cadaverina	+	+		+							3
Pseudacris hypochondriaca	+	+	+	+	+	+	+	+	+		9
*Smilisca baudinii****							+				1
Pipidae (1 species)											
*Xenopus laevis****	+										1
Ranidae (6 species)											
*Lithobates berlandieri****		+									1
*Lithobates catesbeianus****	+	+		+	+			+			5
*Lithobates forreri****					+		+				2
Lithobates yavapaiensis		+									1
Rana boylii			+								1
Rana draytonii	+		+								2
Scaphiopodidae (2 species)											
Scaphiopus couchii		+		+	+	+	+	+		+	7
Spea hammondii	+			+							2
Caudata (3 species)											
Plethodontidae (3 species)											
Aneides lugubris	+								+		2
Batrachoseps major	+		+						+		3
Ensatina eschscholtzii	+		+								2
Squamata (140 species)											
Anguidae (5 species)											
*Elgaria cedrosensis***									+		1
Elgaria multicarinata	+		+	+					+		4
*Elgaria nana***									+		1
*Elgaria paucicarinata***					+		+	+			3
*Elgaria velazquezi***				+	+	+	+				4
Anniellidae (2 species)											
*Anniella geronimensis***	+			+					+		3
Anniella stebbinsi	+								+		2
Bipedidae (1 species)											
*Bipes biporus***				+	+	+	+		+		5
Crotaphytidae (5 species)											
*Crotaphytus grismeri***		+									1
*Crotaphytus insularis***										+	1
Crotaphytus vestigium	+	+		+	+	+	+				6
*Gambelia copeii***	+	+		+	+	+	+		+		7
Gambelia wislizenii		+									1
Eublepharidae (3 species)											
*Coleonyx gypsicolus***										+	1
Coleonyx switaki		+		+	+						3
Coleonyx variegatus	+	+		+	+	+	+	+	+	+	9
Gekkonidae (3 species)											
*Gehyra mutilata****							+				1

Table 4 (continued). Distribution of amphibians and reptiles in the Baja California Peninsula and its adjacent islands, Mexico, by geographic province. Abbreviations: CR = California Region; LCVR = Lower Colorado Valley Region; BCCFR = Baja California Coniferous Forest Region; VR = Vizcaíno Region; CGCR = Central Gulf Coast Region; MR = Magdalena Region; ATR = Arid Tropical Region; SLLR = Sierra La Laguna Region; PIR = Pacific Islands Region; and GIR = Gulf Islands Region. * = species endemic to Mexico; ** = species endemic to Baja California; *** = non-native.

Taxon	Geographic regions of the Peninsula of Baja California and its adjacent islands										Number of regions occupied
	CR	LCVR	BCCFR	VR	CGCR	MR	ATR	SLLR	PIR	GIR	
*Hemidactylus frenatus****				+	+	+	+	+		+	6
*Hemidactylus turcicus****	+	+									2
Iguanidae (9 species)											
*Ctenosaura hemilopha***					+	+	+	+		+	5
*Dipsosaurus catalinensis***										+	1
Dipsosaurus dorsalis		+		+	+	+	+	+	+	+	8
*Iguana rhinolopha****							+				1
Sauromalus ater		+		+	+	+	+			+	6
*Sauromalus hispidus***										+	1
*Sauromalus klauberi***										+	1
*Sauromalus slevini***										+	1
*Sauromalus varius****										+	1
Phrynosomatidae (30 species)											
Callisaurus draconoides	+	+		+	+	+	+	+	+	+	9
Petrosaurus mearnsi	+	+		+						+	4
*Petrosaurus repens***				+	+	+	+			+	5
*Petrosaurus slevini***										+	1
*Petrosaurus thalassinus***							+	+		+	3
Phrynosoma blainvillii	+										1
*Phrynosoma cerroense***	+			+	+	+			+		5
*Phrynosoma coronatum***					+	+	+	+			4
Phrynosoma mcallii		+									1
Phrynosoma platyrhinos		+									1
*Sceloporus angustus***										+	1
*Sceloporus grandaevus***										+	1
*Sceloporus hunsakeri***							+	+		+	3
*Sceloporus licki***							+	+			2
*Sceloporus lineatulus***										+	1
Sceloporus magister		+									1
Sceloporus occidentalis	+		+						+		3
Sceloporus orcutti	+	+	+	+	+	+	+			+	8
Sceloporus vandenburgianus			+								1
*Sceloporus zosteromus***	+			+	+	+	+	+	+	+	8
Uma notata		+									1
Urosaurus graciosus		+									1
*Urosaurus lahtelai***				+							1
Urosaurus nigricaudus	+	+		+	+	+	+	+	+	+	9
Urosaurus ornatus		+									1
*Uta encantadae***										+	1
*Uta lowei***										+	1
*Uta squamata***										+	1
Uta stansburiana	+	+	+	+	+	+	+	+	+	+	10
*Uta tumidarostra***										+	1
Phyllodactylidae (5 species)											
*Phyllodactylus bugastrolepis***										+	1
Phyllodactylus nocticolus	+	+		+	+	+	+		+	+	8
*Phyllodactylus partidus***										+	1
*Phyllodactylus unctus***					+		+	+		+	4
*Phyllodactylus xanti***					+		+	+			3
Scincidae (3 species)											
Plestiodon gilberti	+	+	+								3
*Plestiodon lagunensis***				+	+	+	+	+			5
Plestiodon skiltonianus	+		+						+		3

Table 4 (continued). Distribution of amphibians and reptiles in the Baja California Peninsula and its adjacent islands, Mexico, by geographic province. Abbreviations: CR = California Region; LCVR = Lower Colorado Valley Region; BCCFR = Baja California Coniferous Forest Region; VR = Vizcaíno Region; CGCR = Central Gulf Coast Region; MR = Magdalena Region; ATR = Arid Tropical Region; SLLR = Sierra La Laguna Region; PIR = Pacific Islands Region; and GIR = Gulf Islands Region. * = species endemic to Mexico; ** = species endemic to Baja California; *** = non-native.

Taxon	Geographic regions of the Peninsula of Baja California and its adjacent islands										Number of regions occupied
	CR	LCVR	BCCFR	VR	CGCR	MR	ATR	SLLR	PIR	GIR	
Teiidae (13 species)											
*Aspidoscelis canus***										+	1
*Aspidoscelis carmenensis***										+	1
*Aspidoscelis catalinensis***										+	1
*Aspidoscelis celeripes***										+	1
*Aspidoscelis ceralbensis***										+	1
*Aspidoscelis danheimae***										+	1
*Aspidoscelis espiritensis***										+	1
*Aspidoscelis franciscensis***										+	1
Aspidoscelis hyperythrus	+			+	+	+	+	+	+	+	8
*Aspidoscelis labialis***	+			+							2
*Aspidoscelis maximus***					+		+	+		+	4
*Aspidoscelis pictus***										+	1
Aspidoscelis tigris	+	+		+	+	+	+		+	+	8
Xantusiidae (4 species)											
*Xantusia gilberti***								+			1
Xantusia henshawi	+		+								2
*Xantusia sherbrookei***						+					1
Xantusia wigginsi	+	+		+	+						4
Charinidae (1 species)											
Lichanura trivirgata	+	+		+	+	+	+	+	+	+	9
Colubridae (29 species)											
Arizona elegans	+	+		+							3
*Arizona pacata***				+		+					2
Bogertophis rosaliae		+		+	+	+	+	+		+	7
Lampropeltis californiae	+	+	+	+	+	+	+	+	+	+	10
*Lampropeltis catalinensis***										+	1
*Lampropeltis herrerae***									+		1
Lampropeltis multifasciata			+								1
*Masticophis aurigulus***					+		+	+			3
*Masticophis barbouri***										+	1
Masticophis flagellum		+									1
Masticophis fuliginosus	+	+	+	+	+	+	+	+	+	+	10
Masticophis lateralis	+	+	+	+	+	+					6
Phyllorhynchus decurtatus		+		+	+	+	+			+	6
Pituophis catenifer	+	+	+	+					+		5
*Pituophis insulanus***									+		1
*Pituophis vertebralis***	+			+	+	+	+	+	+	+	8
*Rhinocheilus etheridgei***										+	1
Rhinocheilus lecontei	+	+		+							3
Salvadora hexalepis	+	+	+	+	+	+	+	+	+	+	10
Sonora annulata		+									1
*Sonora cincta***	+	+		+	+				+		5
*Sonora fasciata***					+	+	+		+	+	5
*Sonora mosaueri***				+	+	+	+				4
*Sonora punctatissima***										+	1
*Sonora savagei***										+	1
*Sonora straminea***					+		+	+			3
Sonora semiannulata		+									1
Tantilla planiceps	+	+		+	+	+	+	+		+	8
Trimorphodon lyrophanes	+	+	+	+	+	+	+	+		+	9

Table 4 (continued). Distribution of amphibians and reptiles in the Baja California Peninsula and its adjacent islands, Mexico, by geographic province. Abbreviations: CR = California Region; LCVR = Lower Colorado Valley Region; BCCFR = Baja California Coniferous Forest Region; VR = Vizcaíno Region; CGCR = Central Gulf Coast Region; MR = Magdalena Region; ATR = Arid Tropical Region; SLLR = Sierra La Laguna Region; PIR = Pacific Islands Region; and GIR = Gulf Islands Region. * = species endemic to Mexico; ** = species endemic to Baja California; *** = non-native.

Taxon	Geographic regions of the Peninsula of Baja California and its adjacent islands										Number of regions occupied
	CR	LCVR	BCCFR	VR	CGCR	MR	ATR	SLLR	PIR	GIR	
Dipsadidae (7 species)											
Diadophis punctatus	+								+		2
*Hypsiglena catalinae***										+	1
Hypsiglena chlorophaea		+									1
*Hypsiglena gularis***										+	1
*Hypsiglena marcosensis***										+	1
Hypsiglena ochrorhynchus	+	+	+	+	+	+	+	+	+	+	10
*Hypsiglena slevini***		+		+	+	+	+	+	+	+	8
Elapidae (1 species)											
Hydrophis platurus		+			+	+	+		+	+	6
Leptotyphlopidae (2 species)											
*Rena boettgeri***					+		+	+			3
Rena humilis	+	+		+	+	+	+		+	+	8
Natricidae (4 species)											
Thamnophis elegans			+								1
Thamnophis hammondii	+		+	+	+	+	+				6
Thamnophis marcianus		+									1
*Thamnophis validus***							+	+			2
Typhlopidae (1 species)											
*Indotyphlops braminus****	+			+			+				3
Viperidae (12 species)											
*Crotalus angelensis***										+	1
Crotalus atrox		+								+	2
*Crotalus catalinensis***										+	1
Crotalus cerastes		+			+						2
*Crotalus enyo***	+	+		+	+	+	+	+	+	+	9
Crotalus helleri	+	+	+	+					+		5
*Crotalus lorenzoensis***										+	1
*Crotalus mitchellii***				+	+	+	+	+	+	+	7
*Crotalus polisi***										+	1
Crotalus pyrrhus	+	+	+	+						+	5
Crotalus ruber	+	+	+	+	+	+	+	+	+	+	10
*Crotalus thalassoporus***										+	1
Testudines (11 species)											
Cheloniidae (4 species)											
Caretta caretta	+	+		+	+	+			+	+	7
Chelonia mydas		+		+	+	+	+		+	+	7
Eretmochelys imbricata					+		+		+	+	4
Lepidochelys olivacea	+	+		+	+	+	+		+	+	8
Dermochelyidae (1 species)											
Dermochelys coriacea		+				+	+		+	+	5
Emydidae (3 species)											
Actinemys pallida	+			+							2
*Trachemys nebulosa***				+	+	+	+	+			5
*Trachemys scripta****	+										1
Kinosternidae (1 species)											
*Kinosternon integrum****							+				1
Testudinidae (1 species)											
Gopherus morafkai							+				1
Trionychidae (1 species)											
*Apalone spinifera****		+									1
Total (172 species)											

Table 5. Summary of distributional occurrence of herpetofaunal families in the Baja California Peninsula, Mexico, by geographic region. Abbreviations: CR = California Region; LCVR = Lower Colorado Valley Region; BCCFR = Baja California Coniferous Forest Region; VR = Vizcaíno Region; CGCR = Central Gulf Coast Region; MR = Magdalena Region; ATR = Arid Tropical Region; SLLR = Sierra La Laguna Region; PIR = Pacific Islands Region; and GIR = Gulf Islands Region.

Family	Number of species	Distributional occurrence									
		CR	LCVR	BCCFR	VR	CGCR	MR	ATR	SLLR	PIR	GIR
Bufonidae	6	2	5	1	2	1	1	1	1	1	1
Hylidae	3	2	2	1	2	1	1	2	1	1	—
Pipidae	1	1	—	—	—	—	—	—	—	—	—
Ranidae	6	2	3	2	1	2	—	1	1	—	—
Scaphiopodidae	2	1	1	—	2	1	1	1	1	—	1
Subtotal	**18**	**8**	**11**	**4**	**7**	**5**	**3**	**5**	**4**	**2**	**2**
Plethodontidae	3	3	—	2	—	—	—	—	—	2	—
Subtotal	**3**	**3**	**—**	**2**	**—**	**—**	**—**	**—**	**—**	**2**	
Total	**21**	**11**	**11**	**6**	**7**	**5**	**3**	**5**	**4**	**4**	**2**
Anguidae	5	1	—	1	2	2	1	2	1	3	—
Anniellidae	2	2	—	—	1	—	—	—	—	2	—
Bipedidae	1	—	—	—	1	1	1	1	—	1	—
Crotaphytidae	5	2	4	—	2	2	2	2	—	1	1
Eublepharidae	3	1	2	—	2	2	1	1	1	1	2
Gekkonidae	3	1	1	—	1	1	1	2	1	—	1
Iguanidae	9	—	2	—	2	3	3	4	2	1	8
Phrynosomatidae	30	9	11	4	9	8	8	10	8	6	17
Phyllodactylidae	5	1	1	—	1	3	1	3	2	1	4
Scincidae	3	2	1	2	1	1	1	1	1	1	—
Teiidae	13	3	1	—	3	3	2	3	2	2	12
Xantusiidae	4	2	1	1	1	1	1	—	1	—	—
Subtotal	**83**	**24**	**24**	**8**	**26**	**27**	**22**	**29**	**19**	**19**	**45**
Charinidae	1	1	1	—	1	1	1	1	1	1	1
Colubridae	29	11	15	7	15	14	12	12	9	9	14
Dipsadidae	7	2	3	1	2	2	2	2	2	3	5
Elapidae	1	—	1	—	—	1	1	1	—	1	1
Leptotyphlopidae	2	1	1	—	1	2	1	2	1	1	1
Natricidae	4	1	1	2	1	1	1	2	1	—	—
Typhlopidae	1	1	—	—	1	—	—	1	—	—	—
Viperidae	12	4	6	3	5	4	3	3	3	4	10
Subtotal	**57**	**21**	**28**	**13**	**26**	**25**	**21**	**24**	**17**	**19**	**32**
Cheloniidae	4	2	3	—	3	4	3	3	—	4	4
Dermochelyidae	1	—	1	—	—	—	1	1	—	1	1
Emydidae	3	2	—	—	2	1	1	1	1	—	—
Kinosternidae	1	—	—	—	—	—	—	1	—	—	—
Testudinidae	1	—	—	—	—	—	—	1	—	—	—
Trionychidae	1	—	1	—	—	—	—	—	—	—	—
Subtotal	**11**	**4**	**5**	**—**	**5**	**5**	**5**	**7**	**1**	**5**	**5**
Total	**152**	**49**	**57**	**21**	**57**	**57**	**48**	**60**	**37**	**43**	**82**
Sum total	**172**	**60**	**68**	**27**	**64**	**62**	**51**	**65**	**41**	**47**	**84**

*Sonora punctatissima***
*Sonora savagei***
*Hypsiglena catalinae***
*Hypsiglena gularis***
*Hypsiglena marcosensis***
*Crotalus angelensis***
*Crotalus catalinensis***
*Crotalus lorenzoensis***
*Crotalus polisi***
*Crotalus thalassoporus***

These species are all peninsular endemics, except for one (*Sauromalus varius*) which was introduced to a small islet included in the Gulf Island group (Hollingsworth et al. 1997). These species are all either lizards (26 species) or snakes (13 species).

The peninsular region with the next largest number of single-region species is the LCVR, with 19, as follows (the number following the species name indicates which of the distributional categories is involved):

Anaxyrus cognatus 3
Anaxyrus woodhousii 3
Incilius alvarius 3
*Lithobates berlandieri****2
Lithobates yavapaiensis 3
*Crotaphytus grismeri***
Gambelia wislizenii 3
Phrynosoma mcallii 3
Phrynosoma platyrhinos 3
Sceloporus magister 3
Uma notata 3
Urosaurus graciosus 3
Urosaurus ornatus 3
Masticophis flagellum 3
Sonora annulata 3
Sonora semiannulata 3
Hypsiglena chlorophaea 3
Thamnophis marcianus 7
*Apalone spinifera****

Of these 19 species, 16 (84.2%) are non-endemics, two are introduced species, and one is a peninsular endemic. Of the 16 non-endemic species, all but one are distributed to the north in the United States; and the single exception is the garter snake *Thamnophis marcianus*, which occurs from the United States through Mexico, and into Central America (http://mesoamericanherpetology.com; accessed 5 June 2022). *Crotaphytus grismeri* is endemic to the LCVR, and the two introduced species are from populations outside of Baja California.

The third-largest group of single-region species is found in the ATR region, and is comprised of the following five species:

*Smilisca baudinii****
*Gehyra mutilata****
*Iguana rhinolopha****
*Kinosternon integrum****
Gopherus morafkai 3

Interestingly, four of these five species are introduced, either from elsewhere in Mesoamerica or from outside of Mesoamerica; and the remaining species also is distributed in the United States.

Three regions contain four single-region species. One of these regions is the CR, and the species are as follows:

Anaxyrus californicus 3
*Xenopus laevis****
Phrynosoma blainvillii 3
*Trachemys scripta****

Two of these species are non-native, and the other two also are distributed in the United States.

The second region with four single-region species is the BCCFR, and the species are as follows:

Rana boylii 3
Sceloporus vandenburgianus 3
Lampropeltis multifasciata 3
Thamnophis elegans 3

All four of these species also are distributed to the north in the United States.

In significant contrast to the GIR, the PIR supports only four single-region species, as follows:

*Elgaria cedrosensis***
*Elgaria nana***
*Lampropeltis herrerae***
*Pituophis insulanus***

All of these species are peninsular endemics, like most of the species in the GIR.

Three other regions contain only one single-region species. One is the MR, and the species involved is:

*Xantusia sherbrookei***

This species is a peninsular endemic.

The second region with one single-region species is the SLLR, and the species is:

*Xantusia gilberti***

It also is a peninsular endemic.

The last region with one single-region species is the VR, and the species is:

*Urosaurus lahtelai***

This species is another peninsular endemic.

In summary, of the 78 single-region species found on the peninsula, 46 are peninsular endemics, 23 are non-endemics, and nine are non-native species. Only one of the 10 regions, the CGCR, has no single-region species. Of the 10 phytogeographic regions on the peninsula, the GIR is the most significant with regard to conservation importance, since it contains the largest overall number of species (84), the largest number of single-region species (39), and the greatest number of peninsular endemics (50).

Regional Occupancy and the Coefficient of Biogeographic Resemblance (CBR)

Another indication of conservation significance involving the 10 phytogeographic regions is the relative average regional occupancy (Table 6). This figure is calculated by recording the number of species occupying each of the regions 1 through 10. For example, the CR contains 60 species that occupy regions 1–10 as follows:

Table 6. Numbers of species, regional occupancy, and average regional occupancy for the geographic regions of the Baja California Peninsula and adjacent islands, Mexico. See Table 4 for abbreviations.

Phytogeographic region	Number of species	Species regional occupancy										Total	Average regional occupancy
		1	2	3	4	5	6	7	8	9	10		
CR	60	4	20	30	12	30	24	14	64	63	60	321	5.4
LCVR	68	19	6	21	8	25	36	35	64	63	60	337	5.0
BCCFR	27	4	6	12	8	15	12	0	8	18	60	141	5.2
VR	64	0	10	24	20	45	42	42	88	63	60	394	6.2
CGCR	62	0	4	18	36	35	48	42	88	63	60	394	6.4
MR	51	1	2	6	16	25	48	42	88	63	60	351	6.9
ATR	65	5	6	27	32	20	42	35	88	63	60	378	5.8
SLLR	41	1	4	18	20	15	6	21	56	63	60	264	6.4
PIR	47	4	6	12	8	25	6	28	72	54	60	275	6.3
GIR	84	40	2	9	16	15	24	35	88	54	60	343	4.1
Total	—	78	34	57	44	50	48	42	88	63	60	—	—

CR (60 species)
Region 1 = 4
Region 6 = 4
Region 2 = 10
Region 7 = 2
Region 3 = 10
Region 8 = 8
Region 4 = 3
Region 9 = 7
Region 5 = 6
Region 10 = 6

Based on these data, the mean regional occupancy value for the CR is 5.4 (321/60). The mean regional occupancy values for the 10 regions range from 4.1 to 6.9 (Table 6), as follows (in numerical order):

GIR = 4.1
VR = 6.2
LCVR = 5.0
PIR = 6.3
BCCFR = 5.2
CGCR = 6.4
CR = 5.4
SLLR = 6.4
ATR = 5.8
MR = 6.9

The regional occupancy values roughly indicate the relative conservation significance of each of the 10 regions. Thus, the GIR evidently is the most conservation significant region in the Baja California Peninsula, and the MR is the least. Thus, even though the GIR is the region with the highest herpetofaunal figure (84), it supports the highest degree of single-region species, the peninsular endemic species.

As in other MCS studies, we constructed a Coefficient of Biogeographic Resemblance (CBR) matrix in order to elucidate the similarity relationships among the 10 phytogeographic regions we recognize in the Baja California Peninsula, including its associated islands on both the Pacific and Gulf sides (Table 7). The greatest species richness is contained in the Gulf Island Region (84 species), and the least is in the Baja California Coniferous Forest Region (27 species). The number of shared species between each regional pair ranges from eight between the BCCFR (27 species) and SLLR (41 species), which are relatively small areas located roughly at opposite ends of the peninsula and contain relatively small numbers of species, to 54 between the CGCR (62 species) and ATR (65 species), which are relatively low-elevation regions containing relatively high species numbers and are contiguous in the Cape Region of the peninsula. The mean value of shared species among all 10 regions is 29.9.

The following data show the ranges and means of shared species (bold in parentheses) for each of the 10 regions, and are arranged according to decreasing species richness (underlined values) in each region:

GIR (<u>84</u>): 9–41 (**30.3**)
LCVR (<u>67</u>): 15–43 (**30.4**)
ATR (<u>65</u>): 10–54 (**35.4**)
VR (<u>64</u>): 16–48 (**37.1**)
CGCR (<u>62</u>): 11–54 (**37.3**)
CR (<u>60</u>): 18–45 (**29.3**)
MR (<u>51</u>): 11–48 (**34.1**)
PIR (<u>47</u>): 13–33 (**27.4**)
SLLR (<u>41</u>): 8–39 (**24.9**)
BCCFR (<u>27</u>): 8–23 (**12.9**)

The lowest number of shared species in Table 7, i.e., eight between the BCCFR and the SLLR, is understandable inasmuch as six species occur in all 10 of the phytogeographic regions. These six species are *Uta stansburiana*, *Lampropeltis californiae*, *Masticophis fuliginosus*, *Salvadora hexalepis*, *Hypsiglena ochrorhynchus*, and *Crotalus ruber* (Table 4). The other two species that occur in nine regions are *Pseudacris hypochondriaca* and *Trimorphodon lyrophanes*.

Table 7. Pair-wise comparison matrix of Coefficient of Biogeographic Resemblance (CBR) data of the herpetofaunal relationships for the 10 physiographic regions in the Baja California Peninsula, Mexico. Underlined values = number of species in each region; upper triangular matrix values = species in common between two regions; and lower triangular matrix values = CBR values. The formula for this algorithm is: CBR = $2C/N_1 + N_2$ (Duellman 1990), where C is the number of species in common to both regions, N_1 is the number of species in the first region, and N_2 is the number of species in the second region. See Table 4 for abbreviations. See Fig. 24 for the UPGMA dendrogram produced from the CBR data.

	CR	LCVR	BCCFR	VR	CGCR	MR	ATR	SLLR	PIR	GIR
CR	60	36	23	45	31	28	26	18	33	24
LCVR	0.56	68	15	43	37	33	31	20	27	32
BCCFR	0.53	0.32	27	16	11	11	10	8	13	9
VR	0.73	0.65	0.35	64	48	45	42	27	33	35
CGCR	0.51	0.57	0.25	0.76	62	48	54	36	32	39
MR	0.50	0.53	0.28	0.78	0.85	51	46	28	31	37
ATR	0.42	0.32	0.22	0.66	0.86	0.80	65	39	30	41
SLLR	0.36	0.37	0.24	0.51	0.70	0.61	0.74	41	20	28
PIR	0.62	0.47	0.35	0.59	0.59	0.63	0.54	0.45	47	28
GIR	0.33	0.42	0.16	0.47	0.53	0.55	0.55	0.45	0.43	84

Interestingly and perhaps expectedly, only one of the eight is an amphibian, one is a lizard, and the remaining six are snakes.

In addition, the two insular regions positioned on either side of the peninsula (PIR and GIR) might be expected to share relatively few species. Their number of shared species (28) is higher than the number between the BCCFR and the SLLR (Table 7). These 28 species include the six occurring in all 10 regions, as well as one in four regions, two in five regions, one in six regions, three in seven regions, 10 in eight regions, and five in nine regions. Notably, no insular endemic species are shared between these two insular regions. The six peninsular endemic species found in these two insular regions also are found on the intervening mainland regions, and in total are found in five to nine regions.

The CBR values in Table 6 range from 0.16 between the BCCFR and the GIR to 0.86 between the ATR and the CGCR. These relationships easily are understood given that the BCCFR is a "cool mesic area" occupying the "upper elevations of the northern Sierra Juárez and southern Sierra San Pedro Mártir…" (Grismer, 2002: 12) and the GIR is comprised of the islands in the Gulf region. In addition, the ATR and the CGCR are two regions in the southern portion of the peninsula that are broadly contiguous and overlapping.

UPGMA dendrogram

The UPGMA dendrogram (Fig. 24) indicates that the two most closely related regions are the adjacent and overlapping Central Gulf Coast Region (CGCR) and the Arid Tropical Region (ATR), which are joined at the 0.86 level. These two regions are joined at the 0.82 level with the Magdalena Region (MR), which is adjacent with both of the Central Gulf Coast and Arid Tropical Regions for some distance. These three regions are joined at the 0.74 level with the Vizcaíno Region (VR), which is adjacent to both the Central Gulf Coast and Magdalena Regions. These four regions are joined at the 0.64 level with the Sierra La Laguna Region (SLLR), which is located in the southern cape region of Baja California Sur and surrounded by the Arid Tropical Region. This group of five regions in the southern portion of the Peninsula is joined to the remaining regions in the northern portion of the Peninsula and those in the Pacific Ocean and the Gulf of California at the 0.52 level. Of the remaining five regions, the regions most closely allied are the Pacific Islands Region and the California Region, joined at the 0.62 level. These two regions are united to the other three regions at the 0.51 level with the Lower Colorado Valley Region (LCVR). The eight previously mentioned peninsular regions are joined to the Gulf Islands Region at the 0.44 level. Finally, and notably, the most distantly related region is the Baja California Coniferous Forest Region, which is joined to all the other regions at the 0.33 level and is "the southernmost disjunct and depauperate section of the broader and more inclusive Sierra Montane Conifer Forest" (Grismer 2002: 11–12). This region has the smallest herpetofauna (27 species) of the 10 regions, and the lowest average number of species in common (12.9) with the remaining regions (see above and Table 7).

Distribution Status Categorizations

We used the system developed by Alvarado-Díaz et al. (2013) to discuss the distribution status of the members of the Baja California herpetofauna, as was used in the previous studies in the MCS (see above). The categories in this system have been somewhat adapted to include the following: non-endemic, peninsular endemic, and non-native. The categorizations for each species are listed in Table 8, and summarized in Table 9.

The species numbers in each of the three distribution categories, in decreasing order, are: non-endemics, 81 (47.1%); peninsular endemics, 77 (44.8%); and non-

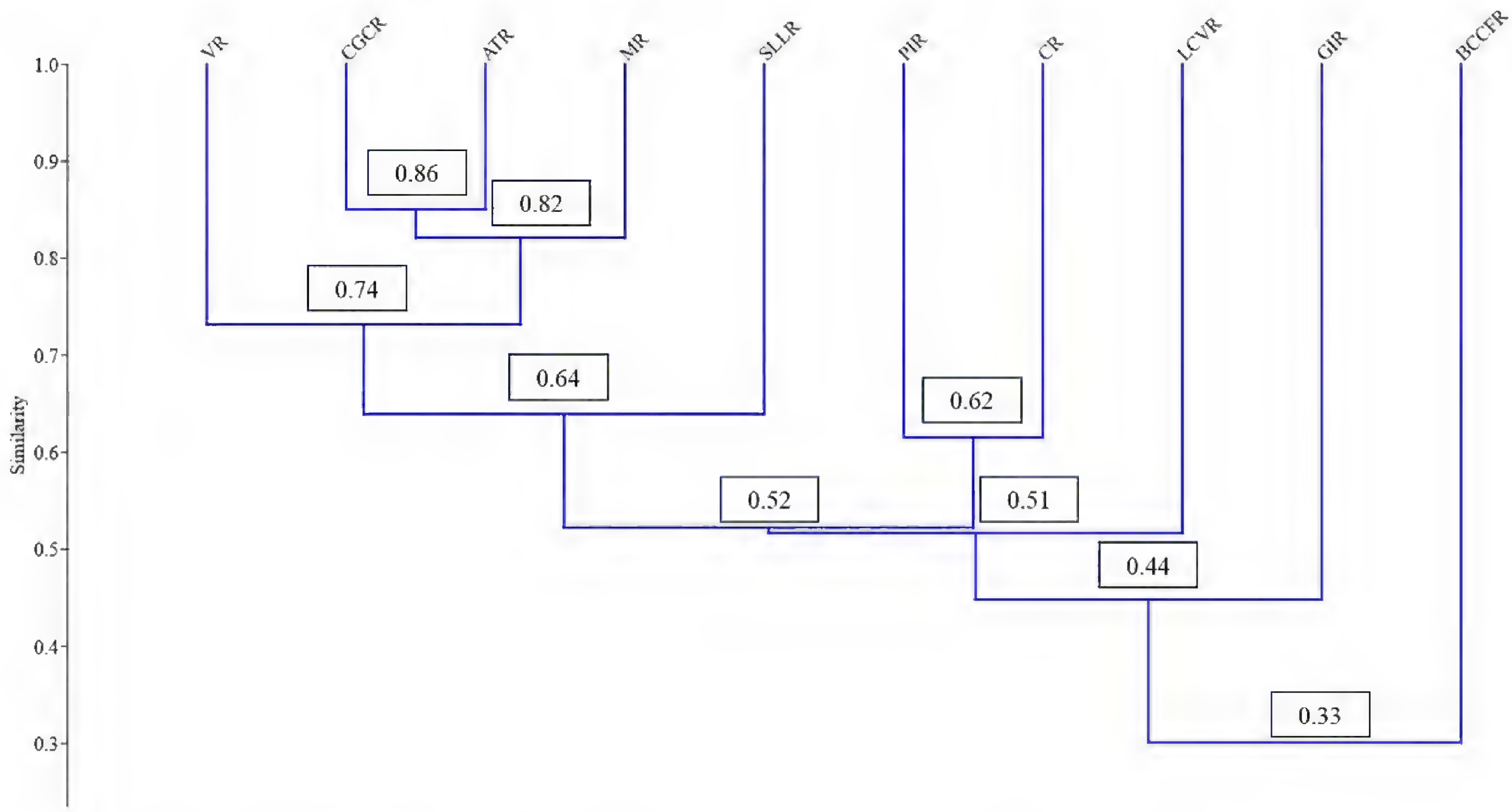


Fig. 24. UPGMA generated dendrogram illustrating the similarity relationships of species richness among the herpetofaunal components in the 10 geographic regions of the Baja California Peninsula (based on the data in Table 6; Sokal and Michener 1958). Similarity values were calculated using Duellman's (1990) Coefficient of Biogeographic Resemblance (CBR).

natives, 14 (8.1%). These distribution categories differ from those utilized in other MCS studies, inasmuch as the Baja California Peninsula is almost completely segmented from the remainder of the country of Mexico, and biogeographically it is much more closely associated with the US state of California (Mata-Silva et al., In Press). Therefore, it is not possible to separate country endemics from state endemics, as was done in the other MCS studies, but rather they are recognized here as only a single category, i.e., the peninsular endemic category (Table 7).

As expected, almost all of the non-endemic species (74, or 91.4% from a total of 81 species) are categorized as NE3 or MXUS species (i.e., species occurring in both Mexico and the United States), according to the categories established by Wilson et al. (2017). However, one species (1.2%) is an NE7 or USCA species (*Thamnophis marcianus*), i.e., a species occurring from the United States to Central America); and six (7.4%) are NE9 or OCEA species (one marine snake, *Hydrophis platurus*, and five marine turtles, *Caretta caretta*, *Chelonia mydas*, *Eretmochelys imbricata*, *Lepidochelys olivacea*, and *Dermochelys coriacea*).

The peninsular endemic species amount to 77 and occupy from one to nine geographic regions (Table 7): one region (46 species, 60.5%); two (four, 5.3%); three (eight, 10.5%); four (five, 6.6%); five (eight, 10.5%); six (none); seven (two, 2.6%); eight (three, 3.9%); and nine (one, 1.3%). The 46 species confined to a single geographic region are either mostly limited to the Pacific Insular Region (four species) or the Gulf Insular Region (38 species). The following four species are confined to the Pacific Insular Region:

*Elgaria cedrosensis***
*Elgaria nana***
*Lampropeltis herrerae***
*Pituophis insulanus***

The 38 species limited to the Gulf Insular Region are:

*Crotaphytus insularis***
*Coleonyx gypsicolus***
*Dipsosaurus catalinensis***
*Sauromalus hispidus***
*Sauromalus klauberi***
*Sauromalus slevini***
*Petrosaurus slevini***
*Sceloporus angustus***
*Sceloporus grandaevus***
*Sceloporus lineatulus***
*Uta encantadae***
*Uta lowei***
*Uta squamata***
*Uta tumidarostra***
*Phyllodactylus bugastrolepis***
*Phyllodactylus partidus***
*Aspidoscelis canus***
*Aspidoscelis carmenensis***
*Aspidoscelis catalinensis***
*Aspidoscelis celeripes***
*Aspidoscelis ceralbensis***
*Aspidoscelis danheimae***
*Aspidoscelis espiritensis***
*Aspidoscelis franciscensis***
*Aspidoscelis pictus***

Table 8. Distributional and conservation status measures for members of the herpetofauna of the Baja California Peninsula, Mexico. Distributional status: PE = endemic to Peninsula of Baja California; NE = not endemic to peninsula; and NN = non-native. The numbers suffixed to the NE category signify the distributional categories developed by Wilson et al. (2017) and implemented in the taxonomic list at the *Mesoamerican Herpetology* website (http://mesoamericanherpetology.com), as follows: 3 (species distributed only in Mexico and the United States); 4 (species found only in Mexico and Central America); 6 (species ranging from Mexico to South America); 7 (species ranging from the United States to Central America); 8 (species ranging from the United States to South America); and 9 (Oceanic species). Environmental Vulnerability Score (taken from Wilson et al. 2013a,b): low (L) vulnerability species (EVS of 3–9); medium (M) vulnerability species (EVS of 10–13); and high (H) vulnerability species (EVS of 14–19). IUCN categorization: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; DD = Data Deficient; and NE = Not Evaluated. SEMARNAT status: A = Threatened; P = Endangered; Pr = Special Protection; and NS = No Status. See Alvarado-Díaz et al. (2013), Johnson et al. (2015a), and Mata-Silva et al. (2015) for explanations of the EVS, IUCN, and SEMARNAT rating systems.

Taxon	Distributional status	Environmental Vulnerability Category (Score)	IUCN categorization	SEMARNAT status
Anaxyrus boreas	NE3	L (7)	LC	NS
Anaxyrus californicus	NE3	M (11)	EN	A
Anaxyrus cognatus	NE3	L (4)	LC	NS
Anaxyrus punctatus	NE3	L (3)	LC	NS
Anaxyrus woodhousii	NE3	M (10)	LC	NS
Incilius alvarius	NE3	M (11)	LC	NS
Pseudacris cadaverina	NE3	M (11)	LC	NS
Pseudacris hypochondriaca	NE3	L (9)	LC	NS
*Smilisca baudinii****	NN	—	—	—
*Xenopus laevis****	NN	—	—	—
*Lithobates berlandieri****	NN	—	—	—
*Lithobates catesbeianus****	NN	—	—	—
*Lithobates forreri****	NN	—	—	—
Lithobates yavapaiensis	NE3	M (12)	LC	Pr
Rana boylii	NE3	M (12)	NT	Pr
Rana draytonii	NE3	M (11)	NT	P
Scaphiopus couchii	NE3	L (3)	LC	NS
Spea hammondii	NE3	M (11)	NT	NS
Aneides lugubris	NE3	H (14)	LC	Pr
Batrachoseps major	NE3	H (14)	LC	NS
Ensatina eschscholtzii	NE3	M (13)	LC	Pr
*Elgaria cedrosensis***	PE	H (16)	LC	NS
Elgaria multicarinata	NE3	M (10)	LC	Pr
*Elgaria nana***	PE	H (16)	LC	NS
*Elgaria paucicarinata***	PE	H (14)	LC	Pr
*Elgaria velazquezi***	PE	H (15)	LC	NS
*Anniella geronimensis***	PE	H (14)	EN	Pr
Anniella stebbinsi	NE3	M (11)	NE	Pr
*Bipes biporus***	PE	H (19)	LC	Pr
*Crotaphytus grismeri***	PE	H (16)	LC	NS
*Crotaphytus insularis***	PE	H (16)	LC	NS
Crotaphytus vestigium	NE3	L (9)	LC	NS
*Gambelia copeii***	NE3	M (11)	LC	NS
Gambelia wislizenii	NE3	M (12)	LC	Pr
*Coleonyx gypsicolus***	PE	H (16)	LC	NS
Coleonyx switaki	NE3	H (10)	LC	NS
Coleonyx variegatus	NE3	M (9)	LC	Pr
*Gehyra mutilata****	NN	—	—	—
*Hemidactylus frenatus****	NN	—	—	—
*Hemidactylus turcicus****	NN	—	—	—
*Ctenosaura hemilopha***	PE	H (16)	LC	Pr
*Dipsosaurus catalinensis***	PE	H (17)	NE	NS
Dipsosaurus dorsalis	NE3	M (12)	LC	NS

Table 8 (continued). Distributional and conservation status measures for members of the herpetofauna of the Baja California Peninsula, Mexico. Distributional status: PE = endemic to Peninsula of Baja California; NE = not endemic to peninsula; and NN = non-native. The numbers suffixed to the NE category signify the distributional categories developed by Wilson et al. (2017) and implemented in the taxonomic list at the *Mesoamerican Herpetology* website (http://mesoamericanherpetology.com), as follows: 3 (species distributed only in Mexico and the United States); 4 (species found only in Mexico and Central America); 6 (species ranging from Mexico to South America); 7 (species ranging from the United States to Central America); 8 (species ranging from the United States to South America); and 9 (Oceanic species). Environmental Vulnerability Score (taken from Wilson et al. 2013a,b): low (L) vulnerability species (EVS of 3–9); medium (M) vulnerability species (EVS of 10–13); and high (H) vulnerability species (EVS of 14–19). IUCN categorization: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; DD = Data Deficient; and NE = Not Evaluated. SEMARNAT status: A = Threatened; P = Endangered; Pr = Special Protection; and NS = No Status. See Alvarado-Díaz et al. (2013), Johnson et al. (2015a), and Mata-Silva et al. (2015) for explanations of the EVS, IUCN, and SEMARNAT rating systems.

Taxon	Distributional status	Environmental Vulnerability Category (Score)	IUCN categorization	SEMARNAT status
*Iguana rhinolopha****	NN	—	—	—
Sauromalus ater	NE3	M (13)	LC	Pr
*Sauromalus hispidus***	PE	H (14)	EN	A
*Sauromalus klauberi***	PE	H (17)	VU	A
*Sauromalus slevini***	PE	H (16)	NT	A
*Sauromalus varius****	NN	—	—	—
Callisaurus draconoides	NE3	M (12)	LC	A
Petrosaurus mearnsi	NE3	M (10)	LC	Pr
*Petrosaurus repens***	PE	H (14)	LC	NS
*Petrosaurus slevini***	PE	H (16)	LC	NS
*Petrosaurus thalassinus***	PE	H (17)	LC	Pr
Phrynosoma blainvillii	NE3	M (12)	LC	NS
*Phrynosoma cerroense***	PE	H (14)	NE	A
*Phrynosoma coronatum***	PE	M (12)	LC	NS
Phrynosoma mcallii	NE3	H (15)	NT	A
Phrynosoma platyrhinos	NE3	M (13)	LC	NS
*Sceloporus angustus***	PE	H (16)	LC	A
*Sceloporus grandaevus***	PE	H (17)	LC	A
*Sceloporus hunsakeri***	PE	H (14)	LC	Pr
*Sceloporus licki***	PE	M (13)	LC	Pr
*Sceloporus lineatulus***	PE	H (17)	LC	A
Sceloporus magister	NE3	L (9)	LC	NS
Sceloporus occidentalis	NE3	M (11)	LC	NS
Sceloporus orcutti	NE3	L (7)	LC	NS
Sceloporus vandenburgianus	NE3	H (14)	LC	Pr
*Sceloporus zosteromus***	PE	M (12)	LC	Pr
Uma notata	NE3	H (15)	NT	P
Urosaurus graciosus	NE3	H (15)	LC	NS
*Urosaurus lahtelai***	PE	H (16)	LC	A
Urosaurus nigricaudus	NE3	L (7)	LC	A
Urosaurus ornatus	NE3	L (9)	LC	NS
*Uta encantadae***	PE	H (17)	VU	NS
*Uta lowei***	PE	H (17)	VU	NS
*Uta squamata***	PE	H (17)	LC	A
Uta stansburiana	NE3	L (5)	LC	A
*Uta tumidarostra***	PE	H (17)	VU	NS
*Phyllodactylus bugastrolepis***	PE	H (17)	LC	A
Phyllodactylus nocticolus	NE3	M (10)	LC	Pr
*Phyllodactylus partidus***	PE	H (16)	LC	Pr
*Phyllodactylus unctus***	PE	H (15)	NT	Pr
*Phyllodactylus xanti***	PE	H (15)	LC	Pr
Plestiodon gilberti	NE3	M (11)	LC	Pr
*Plestiodon lagunensis***	PE	M (13)	LC	Pr

Table 8 (continued). Distributional and conservation status measures for members of the herpetofauna of the Baja California Peninsula, Mexico. Distributional status: PE = endemic to Peninsula of Baja California; NE = not endemic to peninsula; and NN = non-native. The numbers suffixed to the NE category signify the distributional categories developed by Wilson et al. (2017) and implemented in the taxonomic list at the *Mesoamerican Herpetology* website (http://mesoamericanherpetology.com), as follows: 3 (species distributed only in Mexico and the United States); 4 (species found only in Mexico and Central America); 6 (species ranging from Mexico to South America); 7 (species ranging from the United States to Central America); 8 (species ranging from the United States to South America); and 9 (Oceanic species). Environmental Vulnerability Score (taken from Wilson et al. 2013a,b): low (L) vulnerability species (EVS of 3–9); medium (M) vulnerability species (EVS of 10–13); and high (H) vulnerability species (EVS of 14–19). IUCN categorization: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; DD = Data Deficient; and NE = Not Evaluated. SEMARNAT status: A = Threatened; P = Endangered; Pr = Special Protection; and NS = No Status. See Alvarado-Díaz et al. (2013), Johnson et al. (2015a), and Mata-Silva et al. (2015) for explanations of the EVS, IUCN, and SEMARNAT rating systems.

Taxon	Distributional status	Environmental Vulnerability Category (Score)	IUCN categorization	SEMARNAT status
Plestiodon skiltonianus	NE3	M (10)	LC	NS
*Aspidoscelis canus***	PE	H (17)	LC	A
*Aspidoscelis carmenensis***	PE	H (17)	LC	NS
*Aspidoscelis catalinensis***	PE	H (17)	VU	Pr
*Aspidoscelis celeripes***	PE	H (16)	LC	Pr
*Aspidoscelis ceralbensis***	PE	H (17)	LC	Pr
*Aspidoscelis danheimae***	PE	H (17)	LC	A
*Aspidoscelis espiritensis***	PE	H (16)	LC	A
*Aspidoscelis franciscensis***	PE	H (17)	LC	NS
Aspidoscelis hyperythrus	NE3	M (10)	LC	NS
*Aspidoscelis labialis***	PE	H (15)	VU	Pr
*Aspidoscelis maximus***	PE	H (14)	NE	Pr
*Aspidoscelis pictus***	PE	H (17)	LC	A
Aspidoscelis tigris	NE3	L (8)	LC	NS
*Xantusia gilberti***	PE	H (15)	NE	NS
Xantusia henshawi	NE3	M (11)	LC	NS
*Xantusia sherbrookei***	PE	H (15)	NE	NS
Xantusia wigginsi	NE3	M (11)	NE	NS
Lichanura trivirgata	NE3	M (10)	LC	A
Arizona elegans	NE3	L (5)	LC	NS
*Arizona pacata***	PE	H (14)	LC	NS
Bogertophis rosaliae	NE3	M (11)	LC	NS
Lampropeltis californiae	NE3	L (9)	LC	A
*Lampropeltis catalinensis***	PE	H (18)	DD	NS
*Lampropeltis herrerae***	PE	H (20)	LC	A
Lampropeltis multifasciata	NE3	H (14)	NE	A
*Masticophis aurigulus***	PE	H (15)	LC	A
*Masticophis barbouri***	PE	H (17)	DD	A
Masticophis flagellum	NE3	L (8)	LC	A
Masticophis fuliginosus	NE3	L (9)	NE	NS
Masticophis lateralis	NE3	M (12)	LC	NS
Phyllorhynchus decurtatus	NE3	M (12)	LC	NS
Pituophis catenifer	NE3	L (7)	LC	NS
*Pituophis insulanus***	PE	H (17)	LC	NS
*Pituophis vertebralis***	PE	M (13)	LC	NS
*Rhinocheilus etheridgei***	PE	H (17)	DD	A
Rhinocheilus lecontei	NE3	L (8)	LC	NS
Salvadora hexalepis	NE3	L (9)	LC	NS
Sonora annulata	NE3	H (14)	NE	NS
*Sonora cincta***	NE3	L (8)	NE	Pr
*Sonora fasciata***	PE	M (12)	NE	Pr
*Sonora mosaueri***	PE	M (12)	NE	NS
*Sonora punctatissima***	PE	H (15)	NE	Pr

Table 8 (continued). Distributional and conservation status measures for members of the herpetofauna of the Baja California Peninsula, Mexico. Distributional status: PE = endemic to Peninsula of Baja California; NE = not endemic to peninsula; and NN = non-native. The numbers suffixed to the NE category signify the distributional categories developed by Wilson et al. (2017) and implemented in the taxonomic list at the *Mesoamerican Herpetology* website (http://mesoamericanherpetology.com), as follows: 3 (species distributed only in Mexico and the United States); 4 (species found only in Mexico and Central America); 6 (species ranging from Mexico to South America); 7 (species ranging from the United States to Central America); 8 (species ranging from the United States to South America); and 9 (Oceanic species). Environmental Vulnerability Score (taken from Wilson et al. 2013a,b): low (L) vulnerability species (EVS of 3–9); medium (M) vulnerability species (EVS of 10–13); and high (H) vulnerability species (EVS of 14–19). IUCN categorization: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; DD = Data Deficient; and NE = Not Evaluated. SEMARNAT status: A = Threatened; P = Endangered; Pr = Special Protection; and NS = No Status. See Alvarado-Díaz et al. (2013), Johnson et al. (2015a), and Mata-Silva et al. (2015) for explanations of the EVS, IUCN, and SEMARNAT rating systems.

Taxon	Distributional status	Environmental Vulnerability Category (Score)	IUCN categorization	SEMARNAT status
*Sonora savagei***	PE	H (16)	LC	Pr
*Sonora straminea***	PE	H (15)	NE	Pr
Sonora semiannulata	NE3	L (6)	LC	NS
Tantilla planiceps	NE3	L (8)	LC	NS
Trimorphodon lyrophanes	NE3	M (11)	LC	NS
Diadophis punctatus	NE3	L (4)	LC	NS
*Hypsiglena catalinae***	NN	H (16)	NE	Pr
Hypsiglena chlorophaea	NE3	M (10)	LC	NS
*Hypsiglena gularis***	PE	H (16)	LC	NS
*Hypsiglena marcosensis***	PE	H (16)	NE	NS
Hypsiglena ochrorhynchus	NE3	M (10)	NE	Pr
*Hypsiglena slevini***	PE	M (11)	LC	NS
Hydrophis platurus	NE9	—	LC	NS
*Rena boettgeri***	PE	H (14)	NE	NS
Rena humilis	NE3	L (8)	LC	NS
Thamnophis elegans	NE3	H (14)	LC	A
Thamnophis hammondii	NE3	M (12)	LC	A
Thamnophis marcianus	NE7	L (9)	LC	A
*Thamnophis validus***	PE	M (11)	LC	NS
*Indotyphlops braminus****	NN		—	—
*Crotalus angelensis***	PE	H (18)	LC	NS
Crotalus atrox	NE3	L (9)	LC	Pr
*Crotalus catalinensis***	PE	H (19)	CR	A
Crotalus cerastes	NE3	H (16)	LC	Pr
*Crotalus enyo***	PE	M (13)	LC	A
Crotalus helleri	NE3	M (12)	NE	Pr
*Crotalus lorenzoensis***	PE	H (19)	LC	NS
*Crotalus mitchellii***	PE	H (15)	LC	Pr
*Crotalus polisi***	PE	H (19)	NE	Pr
Crotalus pyrrhus	NE3	M (13)	NE	Pr
Crotalus ruber	NE3	L (9)	LC	Pr
*Crotalus thalassoporus***	PE	H (19)	NE	Pr
Caretta caretta	NE9	—	LC	P
Chelonia mydas	NE9	—	EN	P
Eretmochelys imbricata	NE9	—	CR	P
Lepidochelys olivacea	NE9	—	VU	P
Dermochelys coriacea	NE9	—	CR	P
Actinemys pallida	NE3	M (13)	VU	NS
*Trachemys nebulosa***	PE	H (15)	NE	NS
*Trachemys scripta****	NN	—	—	—
*Kinosternon integrum****	NN	—	—	—
Gopherus morafkai	NE3	H (15)	NE	A
*Apalone spinifera****	NN	—	—	—

Table 9. Summary of the distributional status data for the herpetofaunal families in the Baja California Peninsula, Mexico.

Family	Number of species	Distributional status		
		Non-endemic (NE)	Peninsular Endemic (CE)	Non-native (NN)
Bufonidae	6	6	—	—
Hylidae	3	2	—	1
Pipidae	1	—	—	1
Ranidae	6	3	—	3
Scaphiopodidae	2	2	—	—
Subtotal	**18**	**13**	**—**	**5**
Plethodontidae	3	3	—	—
Subtotal	**3**	**3**	**—**	**—**
Total	**21**	**16**	**—**	**5**
Anguidae	5	1	4	—
Anniellidae	2	1	1	—
Bipedidae	1	—	1	—
Crotaphytidae	5	2	3	—
Eublepharidae	3	2	1	—
Gekkonidae	3	—	—	3
Iguanidae	9	2	5	2
Phrynosomatidae	30	14	16	—
Phyllodactylidae	5	1	4	—
Scincidae	3	2	1	—
Teiidae	13	2	11	—
Xantusiidae	4	2	2	—
Subtotal	**83**	**29**	**49**	**5**
Boidae	1	1	—	—
Colubridae	29	15	14	—
Dipsadidae	7	3	4	—
Elapidae	1	1	—	—
Leptotyphlopidae	2	1	1	—
Natricidae	4	3	1	—
Typhlopidae	1	—	—	1
Viperidae	12	5	7	—
Subtotal	**57**	**29**	**27**	**1**
Cheloniidae	4	4	—	—
Dermochelyidae	1	1	—	—
Emydidae	3	1	1	1
Kinosternidae	1	—	—	1
Testudinidae	1	1	—	—
Trionychidae	1	—	—	1
Subtotal	**11**	**7**	**1**	**3**
Total	**151**	**65**	**77**	**9**
Sum total	**172**	**81**	**77**	**14**

*Lampropeltis catalinensis***
*Masticophis barbouri***
*Rhinocheilus etheridgei***
*Sonora punctatissima***
*Sonora savagei***
*Hypsiglena catalinae***
*Hypsiglena gularis***
*Hypsiglena marcosensis***
*Crotalus angelensis***
*Crotalus catalinensis***
*Crotalus lorenzoensis***
*Crotalus polisi***
*Crotalus thalassoporus***

The 14 non-native species include five anurans (*Smilisca baudinii*, *Xenopus laevis*, *Lithobates berlandieri*, *L. catesbeianus*, and *L. forreri*), five lizards (*Gehyra mutilata*, *Hemidactylus frenatus*, *H. turcicus*, *Iguana rhinolopha*, and *Sauromalus varius*), one snake (*Indotyphlops braminus*), and three turtles (*Trachemys scripta*, *Kinosternon integrum*, and *Apalone spinifera*). The most widespread of these introduced species in

Mexico are *Hemidactylus frenatus* and *Indotyphlops braminus* (González-Sánchez et al. 2021), and the most widely distributed of these species in the Baja California peninsula is *Hemidactylus frenatus* (Table 4).

Principal Environmental Threats

The main threat to the planet's biodiversity is the combination of human population growth and the exploitation of natural resources. The human population requires resources to survive and grow, and these resources often are removed from the environment in unsustainable ways. This problem becomes larger as the human population grows. As threats to biodiversity are occurring worldwide, Mexico also is subject to many of these threats (Santos-Barrera et al. 2021), and the Baja California Peninsula is no exception. In this section we highlight the most significant problems we believe are affecting the conservation of amphibian and reptile populations in the Baja California Peninsula.

Land conversion and habitat loss. In general, this threat is the major reason for biodiversity loss (Leclère et al. 2020; Bellard et al. 2022), and specifically for amphibians and reptiles (Wake 1991; Gibbons et al. 2000; Böhm et al. 2013). In the Baja California Peninsula, a large part of this threat occurs mainly in coastal areas where the vegetation has been cleared, and the habitat has been lost as a result of tourism and housing development. For example, *Aspidoscelis tigris* and *Dipsosaurus dorsalis* were affected by habitat loss in the coastal sand dunes of San Felipe (Gatica-Colima 1998). This activity is more common in the Gulf of California due to the attractiveness of its beaches. Many of these mega-developments involve the clearing of large sections of natural land for the construction of buildings, golf courses, and marinas, which alter both the terrestrial and marine habitats, as well as coastal dunes and riparian areas (Rodríguez-Revelo et al. 2014b).

In other regions, the expansion of agricultural areas also affects a large part of the habitats of many species throughout the peninsula (Fig. 25). Most of these crops are monocultures that serve as an ecological trap for organisms inhabiting nearby natural semiarid habitats (Rotem et al. 2013). One of the areas most affected by this activity is the Santo Domingo Valley in the Magdalena region of Baja California Sur. This area covers just over 260,000 ha and includes many isolated fragments of native vegetation that still contain native reptile species; nevertheless, extirpations have been detected, such as that of *Urosaurus nigricaudus* (Munguía-Vega et al. 2013). Perhaps this also is the case with other species of lizards and snakes in such agricultural areas as the Valley of Mexicali in northeastern Baja California, which covers about 280,000 ha. Another agricultural area with constant expansion is that between Colonet and San Quintín in northwestern Baja California, which has affected the coastal scrub vegetation and dune areas (Vanderplank

Fig. 25. Cleared land used for agriculture in San Quintín. This area was the habitat of *Anniella geronimensis*, and now is used by Driscoll's to grow berries for export to the USA. The Riveroll Volcano is evident in the background, which is the habitat of *Batrachoseps major* and *Ensatina eschscholtzii.* Agriculture and rock/sand mining activities continue to threaten these unique populations of salamanders. *Photo by Jorge H. Valdez-Villavicencio.*

et al. 2014a), thereby causing a reduction in the habitat of the endemic lizard *Anniella geronimensis*, as well as other endemic species (e.g., *Aspidoscelis labialis* and *Sceloporus zosteromus*).

Mining concessions along the peninsula also imply the destruction of natural habitat, the excessive use of water, and habitat fragmentation due to the construction of access roads. In a short period between 2009 and 2010, 141 mining concessions were granted in the state of Baja California Sur, at least five of which are located in the Cape Region, which affected nearly 50,000 ha of habitat for many reptile species endemic to this region (Galina-Tessaro et al. 2015). Other mining activities, such as the extraction of sand from riparian areas that is used for construction and exported to the United States, have affected the habitat of the Arroyo Toad (*Anaxyrus californicus*) and the California Red-legged Frog (*Rana draytonii*) in northwestern Baja California; and both species are included in Mexico's list of threatened species (Lovich et al. 2009).

Water diversion and overuse. Aquatic habitats are threatened by the alteration of their physical or biotic structures based on the various ways humans use water supplies and the adjacent habitats (Figs. 26–28). The channelization of streams and excessive pumping of groundwater and surface water have the greatest effects on the aquatic habitats and their associated species (Jennings and Hayes 1994). Due to the aridity of the peninsula and the declining precipitation, evidently there is a diminution and a lack of recharge of the aquifers; therefore, the excessive use of water represents a strong threat to such freshwater species as amphibians and reptiles (e.g., *Thamnophis* and *Actinemys*). Notably, the extraction of water for domestic and agricultural consumption has affected the hydrology of the basins in northwestern Baja California. The excessive use of water for irrigation in agricultural areas is reducing the water levels in streams, and also causing the loss of ponds and areas with the historical presence of species such as *Anaxyrus californicus*, *Rana draytonii*, and *Actinemys pallida* (Peralta-García et al. 2016; Valdez-Villavicencio et al., In Press). In most of the watersheds the surface water no longer occurs near the coast, and in some cases it is up to 20 km inland, due to the presence of a large number of pumps used to extract the groundwater and a network of surface pipes used to distribute water throughout the agricultural region between Colonet and San Quintín.

Baja California Sur is no exception, as many of the aquifers there are overexploited, and with the scarcity of rainfall, the recharge of the aquifers is insufficient (Carrillo-Guerrero 2010; Troyo-Diéguez et al. 2010). Large amounts of water are destined for agricultural use. For example, 78% of the state's water is destined for agricultural use and 15% for public establishments such as shopping areas and hotel complexes, whose numbers keep increasing with each passing year (Graciano 2013). This situation has caused a water deficit of 54% in the state's aquifers (DOF 2020). Therefore, many of the streams and small oases no longer have the surface water which is vital for the survival of amphibians and reptiles (e.g., *Trachemys nebulosa* and *Thamnophis hammondii*).

Invasive species. Introduced species are considered one of the main causes of amphibian and reptile

Fig. 26. An aerial image of San Quintín agricultural valley, which surrounds Arroyo Santo Domingo. A large patch of wetland was present at the mouth of the stream, but became dry. Agricultural activities promote habitat loss through land clearing and water overextraction, which leads to soil salinization. *Photo by Jorge H. Valdez-Villavicencio.*

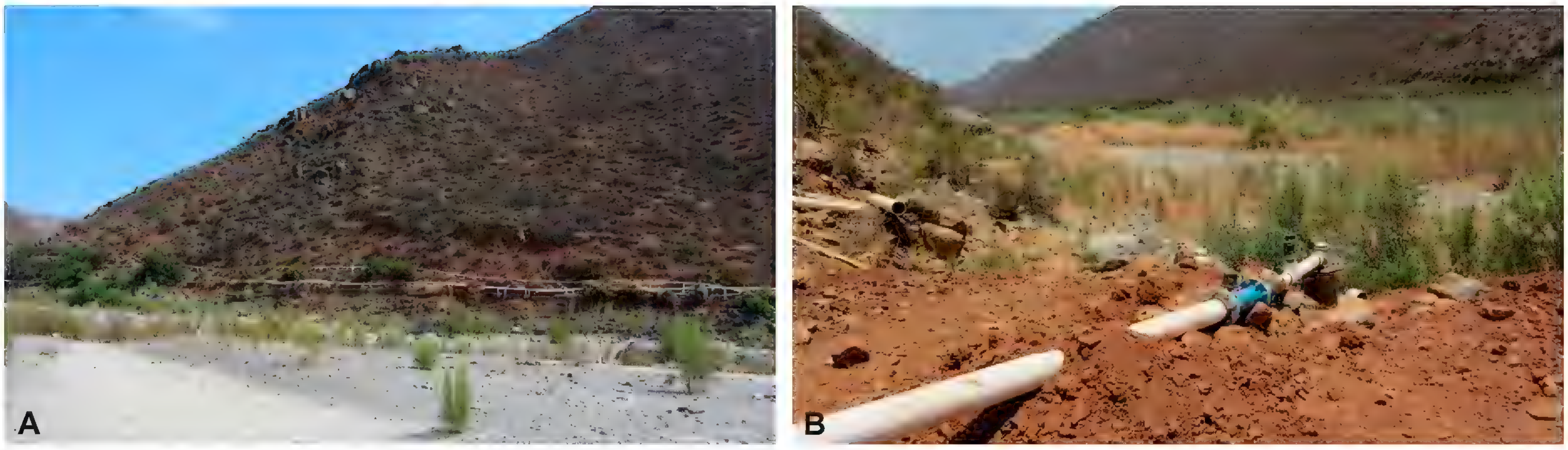


Fig. 27. Arroyo Santo Domingo, Baja California. **A.** Kilometers of water pipelines are used along Arroyo Santo Domingo to irrigate crops in the San Quintín valley; **B.** A well at Arroyo Santo Domingo. INEGI catalogued this arroyo as overexploited, but water extraction activities continue. *Photo by Jorge H. Valdez-Villavicencio.*

Fig. 28. In the San Quintín Valley, fields are irrigated for agriculture. This area was the habitat of *Anniella geronimensis* and *Aspidoscelis labialis*, both endemic species in this area. *Photo by Jorge H. Valdez-Villavicencio.*

declines (Blackburn et al. 2019; Cox et al. 2022), especially on island systems where invasive species are the main threat (Aguirre-Muñoz et al. 2016). Many of the alien species affect native species (Figs. 29–30), not only through direct predation, but also by competing for prey, modifying/eliminating habitat, and spreading disease (Holland 1994; Kats and Ferrer 2003; Bury et al. 2012).

Many species of mammals have been introduced on the islands associated with the Baja California Peninsula, some of which contribute to habitat loss and modification (e.g., goats), competition, and predation (e.g., rats, cats, and dogs). Cats prey directly on lizards and snakes, and could be their main threat on islands (Arnaud et al. 2008). Fortunately, many of these invasive species have been eradicated from several of these islands (Aguirre-Muñoz et al. 2016), but they still are present on some of the islands, which represents a threat to the unique species in these island habitats.

In the northwestern region of the peninsula, a low abundance of amphibians, and the absence of *Rana draytonii* in particular, have been reported at sites where exotic species are present (Peralta-García et al. 2016). The same situation has been observed with the pond turtle *Actinemys pallida* in the presence of Bullfrogs (*Lithobates catesbeianus*; Valdez-Villavicencio et al., In Press). This same phenomenon occurs in many oases along the peninsula where various introduced species (e.g., *Tilapia zilli*, *Procambarus clarkii*, and *L. catesbeianus*) are found, which might be affecting the amphibian populations (Luja et al. 2016). In northeastern Baja California, the native anurans *Incilius alvarius* and *Lithobates yavapaiensis* perhaps have been extirpated due to the introductions of the Bullfrog and various fish species (Grismer 2002).

Fig. 29. Invasive Bullfrogs (*Lithobates catesbeianus*) at Valle de Guadalupe, Baja California. This species has dispersed throughout this valley due to growth in the wine industry, which usually includes reservoirs for irrigation or attractions for customers. Sunfish and Largemouth Bass have been released into these reservoirs, which threaten native amphibians and reptiles. *Photo by Andrea Navarro-Tiznado.*

Fig. 30. An adult *Hypsiglena ochrorhynchus* was found in the stomach of a Bullfrog (*Lithobates catesbeianus*) at Rancho Madrigal, Ensenada, Baja California. Efforts to eradicate these frogs are being made at this site. *Photo by Jorge H. Valdez-Villavicencio.*

In this same region, a reduction in the diversity of amphibian and reptile species also has been reported in disturbed sites of the Colorado River that have been invaded by exotic vegetation (Valdez-Villavicencio et al. 2021). Introduced plants can have serious negative effects on the environment and represent another threat to the survival of reptiles, since they can significantly reduce the richness and abundance of the insects that are the main food for many species of reptiles (Valentine et al. 2007; Schirmel et al. 2016). For example, the legless lizard *Anniella stebbinsi* appears to be affected by the invasion of ice plants (*Carpobrotus edulis* and *Mesembryanthemum crystallinum*) in the coastal dunes of northwestern Baja California (Manrriquez-Gomez et al. 2021). The same situation occurs in coastal dunes between San Quintín and El Socorro, where the

Fig. 31. Livestock grazing at La Grulla, Sierra San Pedro Mártir, Baja California, a high-elevation meadow at 2,250 m asl. The lack of livestock management affects local herpetofaunal populations, including those of *Rana draytonii*, *Anaxyrus californicus*, and *Thamnophis elegans. Photo by Jorge H. Valdez-Villavicencio.*

Fig. 32. Livestock wandering along the side of Arroyo Valladares, Baja California. *Photo by Anny Peralta-García.*

abundance of *Anniella geronimensis* has been observed to be much lower in patches with ice plants, when compared to patches of native vegetation (APG and JHVV, unpub. data).

Invasive plants on island systems also might be affecting the survival of amphibians and reptiles. In recent years, the increase of non-native grass species has been observed on some Pacific islands. Introduced grasses have been shown to alter the structure and function of ecosystems, thereby causing negative impacts on native species (García and Clusella-Trullas 2019), since they can reduce the availability of microhabitats, and also alter the thermal quality of the habitat (Carter et al. 2015; Schlesinger et al. 2020; Lara-Reséndiz et al. 2022). For example, a low abundance of *Lampropeltis herrerae* has been observed on Todos Santos Island, perhaps caused by introduced grasses (Pampa-Ramírez 2021), in addition to a low abundance of lizards.

In other habitats such as oases, introduced plants represent a serious threat. The Rubber Vine (*Cryptostegia grandiflora*) is an aggressive invasive plant that has been introduced into at least 22 oases in Baja California Sur, and likely is affecting amphibians and reptiles associated with these unique habitats (Valentine et al. 2007; Rodríguez-Estrella et al. 2010).

Livestock grazing. Livestock production is an important part of the economies of both states in the Baja California Peninsula, as the percentage of land use for cattle is over 50% (SEMARNAT 2003). The effects of ranching and livestock on wildlife need to be better documented (but see Figs. 31–32). However, overgrazing likely has led to a major problem in the meadows of northwestern Baja California, causing their disappearance and impacting riparian wildlife species, including amphibians such as *Rana draytonii* and *Anaxyrus californicus* (Mellink and

Fig. 33. A Southwestern Pond Turtle (*Actinemys pallida*) trampled by cattle along Arroyo San Vicente, Baja California. *Photo by Anny Peralta-García.*

Contreras 2014; Peralta-García et al. 2016). Remnant meadows might be affected by the water quality changes associated with grazing, leading to the demise of local amphibian populations (Smalling et al. 2021). In Baja California Sur, the tropical deciduous forest has been overgrazed for over 200 years; and during this time, grazing has changed the vegetational structure and composition of the Cape Region, thus affecting wildlife through habitat loss (Jaramillo 1994; Arriaga 2006). In general, habitats with a relatively complex structures support more diverse animal communities than those with simple structures, due to the provision of a greater range of available niches that can be exploited (Pianka 1966).

Livestock grazing has been associated with a lower density and structure of the vegetation and seed production, soil compaction, the lowering of water filtration, increased erosion, as well as modification of the available oxygen, chemical composition, microorganisms, and fertility (Mellink and Contreras 2014; Jofré and Reading 2012). In the Baja California Peninsula, the abundance of three species of frogs and four species of lizards was lower in grazed areas than in ungrazed areas (Arguelles-Méndez et al. 1996; Romero-Schmidt et al. 1994; Romero-Schmidt and Ortega-Rubio 1999). The differences were attributed to a reduction in the protective cover from predators and food availability for insects. Furthermore, cattle might have a direct effect by disturbing individuals or even crushing them as they wander in their habitat. Cattle grazing had a detrimental effect on lizard populations. For example, Busack and Bury (1974) found negative effects on *Gambelia wislizenii* and *Phrynosoma platyrhinos* (two species found in Baja California), because grazing had altered their preferred habitats and the availability of food.

Dead individuals of *Actinemys pallida* have been found on stream banks (Fig. 33), showing signs of being crushed by livestock (APG and JHVV, pers. obs.). Grazing and trampling led to an overall decline in reptile population abundance, changes in reptile species composition, and reduced reptile diversity in the majority of the habitat types where it has been studied (Jofré and Reading 2012). However, more research is needed to understand the effect of grazing on amphibians and reptiles in the Baja California Peninsula.

Illegal trade. Currently, many species of amphibians and reptiles that are rare or endemic, or that inhabit particular areas such as islands, are attractive to collectors and often are illegally collected and traded, which can lead to over-collecting, consequently affecting their survival (Auliya et al. 2016; Marshall et al. 2020). The herpetofauna of the Baja California Peninsula is known to be subject to the illegal collecting and trafficking of species (Mellink 1995; Grismer 2002). Many insular endemic species are subject to illegal collection and trade. The Baja California associated islands harbor numerous endemic species that are subject to the pet trade, especially rattlesnakes (Pliego-Sánchez et al. 2021) and the Todos Santos Island Kingsnake (*Lampropeltis herrerae*). Collectors turning over rocks and snake traps have been reported on Isla Todos Santos (Mellink 1995). In 2007, APG and JHVV also found several abandoned traps, and recently Pampa-

Fig. 34. Car and motorcycle tracks seen in the vicinity of turtle nesting sites at Punta Arena, north of Cabo Pulmo, Baja California Sur. These activities remain a common practice along these areas. *Photo by Alan Harper.*

Ramírez (2021) reported finding three more abandoned traps. However, we do not know whether this species presently continues to be attractive for illegal collection. The search for and illegal collection of reptiles also has led to the degradation of the habitat of rock-dwelling species (Goode et al. 2004, 2005), such as the rocky habitat of the snakes *Lampropeltis multifasciata* and *Lichanura trivirgata*, and rock-dwelling lizards (e.g., *Petrosaurus* and *Sauromalus*). Reports of the illegal removal of large numbers of the endemic *Petrosaurus thalassinus* in the Cape Region of Baja California Sur have been published (Grismer 2002; Lovich et al. 2009).

Recently, we have seen social media posts of people purchasing individuals of *Bipes biporus* and *Phrynosoma* species from Baja California. This practice encourages the local people to illegally (sometimes unknowingly) collect reptile species to sell to these types of buyers.

Off-road activities. Off-road vehicle driving (Figs. 34–35) is a common outdoor recreational activity in the Baja California Peninsula (Gaeta-Verdín 2020). The use of these types of vehicles (quads, buggies, racers, etc.) has increased significantly in recent years, but there are few regulations on how and where these recreational activities can be undertaken. Today, these activities are a common tourist attraction along the coasts of the peninsula, where rental services for these vehicles are offered. Few studies in Baja California have evaluated whether these activities affect biodiversity, but studies elsewhere have shown the negative effects on reptiles in desert habitats due to the loss of vegetational cover, a reduction in the abundance of invertebrates, and the disturbance of the daily activities of reptiles (Busack and Bury 1974; Bury et al. 1977). One example is the alteration of the coastal dunes in northwestern Baja California (El Descanso dunes, and La Lagunita in Ensenada), where the vegetation has been lost completely due to the use of all-terrain vehicles (Rodríguez-Revelo et al. 2014a), and it surely has affected species such as *Anniella stebbinsii* and *Sceloporus zosteromus*. These types of activities also could be affecting other species, including *Phrynosoma mcallii*, *Uma notata*, and *Crotalus cerastes* (included in NOM-059), as they may be run over by off-road vehicles passing through Laguna Salada or the Cuervitos-Algodones dunes in Mexicali. The use of these vehicles in riparian areas also is a common activity, sometimes directly in the streambeds, where they affect freshwater turtles and tadpoles or amphibian egg masses. Baja California Sur is no exception. Due to the increasing amount of tourism, numerous places now offer these types of recreational activities, and mainly in coastal areas. Sea turtle nesting areas also have been affected by tourists or local people who do not respect the posted signs, and use motorcycles and cars to enter the sand dunes where turtles nest (Vanderplank et al. 2014b). High-speed off-road vehicle races are held in Baja California each year (e.g., Baja 1,000, 500, 400, and 250 mile races). Nearly 300 vehicles participate in the Baja 1,000 and travel along the dirt roads and trails along the peninsula, and even through natural protected areas. These vehicles likely are causing irreparable damage to the arid and semi-arid environments of the Baja California peninsula, since constant traffic compacts the soil, destroys the vegetation, and promotes erosion (Gaeta-Verdín 2020). Given the characteristics of these vehicles, *Scaphiopus couchii* and *Spea hammondii* burrows can be susceptible to the disturbance caused by the vehicles that generate noise and produce vibrations

Fig. 35. Well-traveled road along a streambed at Cañón El Alamo, Arroyo Las Palmas, Baja California. Several species of amphibians and reptiles, including Southwestern Pond Turtles (*Actinemys pallida*), inhabit this stream. *Photo by Anny Peralta-García.*

similar to rain, inducing their emergence under highly unfavorable conditions (hot and dry) that would be fatal for adults (Jennings and Hayes 1994). Another problem with this activity is that the routes are not permanent, and every year they change and affect different areas. The traffic caused by local vehicles also is a problem, as thousands of spectators also travel along the dirt roads to watch the races at different points, and they surely run over a large number of lizards and snakes, in addition to the problem of improperly disposing of their garbage (Gaeta-Verdín 2020).

Infectious diseases. Infectious diseases are considered one of the main threats to amphibians worldwide, resulting in the declines and local extinctions of many species. One of the main diseases is chytridiomycosis, an infectious disease caused by the pathogenic fungi *Batrachochytrium dendrobatidis* and *B. salamandrivorans* (Skerratt et al. 2007; Adams et al. 2022). For reptiles, some infectious diseases also have emerged and affected wild populations through disease transmission, such as the one in snakes caused by the fungus *Ophidiomyces ophiodiicola*, and the turtle shell disease caused by *Emydomyces testavorans* (Haynes et al. 2021; Lambert et al. 2021).

Only a few studies in the Baja California Peninsula have investigated diseases in amphibians, and they have focused on *B. dendrobatidis* (Bd). Bd has been recorded in both states, with museum records detecting the pathogen as early as 1932 in Baja California (Adams et al. 2022). In the northern state, this fungus has been detected in *Anaxyrus californicus*, *A. boreas*, *Pseudacris cadaverina*, *P. hypochondriaca*, *Rana draytonii*, and the exotic *Lithobates catesbeianus*, with only *Xenopus laevis* testing negative (Peralta-García et al. 2018). In

Baja California Sur, Bd also has been detected in *L. catesbeianus* and *P. hypochondriaca* (Luja et al. 2012). Bd-positive sites occurred at elevations ranging from sea level to 2,070 m asl.

The presence of the non-native American Bullfrog (*Lithobates catesbeianus*), a competent Bd vector and reservoir host (Schloegel et al. 2012; Adams et al. 2017), has been associated with higher Bd prevalence in native anurans in Baja California (Luja et al. 2012). Increased Bd prevalence in Baja California also has been observed at higher elevations, and with greater remoteness from urban areas and agricultural land (Peralta-García et al. 2018). Adams et al. (2022) found an overall Bd prevalence of 68%, with species being an important predictor of pathogen prevalence and burden (load) both across and within sites. Species distribution models of Bd predict high suitability for the pathogen in northwestern Baja California, based on environmental factors (Bolom-Huet et al. 2019). Infections higher than >10,000 ZE (where ZE is a measure of infection intensity) have been observed in Baja California frogs, particularly in *A. boreas* and *R. draytonii*, with a higher prevalence at higher elevation sites (Peralta-García et al. 2018; Adams et al. 2022), prompting the need for further investigations of Bd in this region.

No diseases have been detected for reptiles, but follow-up studies are important because some diseases have been detected in snakes and turtles in the neighboring state of California (Haynes et al. 2021; Lambert et al. 2021).

Climate change. Climate change has become one of the main threats to biodiversity (Pereira et al. 2010; Bellard et al. 2012). Some of the main effects of climate change are changes in temperatures that can accelerate the loss and degradation of habitat, promote changes in the abundance and structure of communities, and alter the distribution of species, in addition to accelerating the extinction of species at different scales (Bellard et al. 2012). In the case of reptiles, many studies have examined the impact of climate change and indicate severe effects on these organisms (Sinervo et al. 2010; Meiri et al. 2013). Climate change represents a threat for most reptiles since it can reduce their hours of activity, thereby causing the alterations in many of their physiological processes, reproduction, and feeding (Sinervo et al. 2010).

In the Baja California Peninsula, species with restricted distributions or species with fossorial habits are the ones that primarily will be affected. For example, climate change effect models show that *Anniella geronimensis* and *Bipes biporus* would experience negative impacts on their distributions (Lara-Reséndiz et al. 2020). Conversely, some thermophilic and widely distributed species (e.g., *Dipsosaurus dorsalis*) might not be as threatened by climate change (Lara-Reséndiz et al. 2019). Fossorial species (such as *Anniella geronimensis* and *Bipes biporus*) may also be impacted under projected climate change scenarios, in which reduced dispersal and mobility may be coupled with reduced suitable habitat (Lara-Reséndiz et al. 2020).

The effects of climate change could present a severe threat to insular systems, since amphibians and reptiles obviously cannot expand or modify their distributions to compensate for its effects. Among terrestrial vertebrates on islands, reports show that amphibians and reptiles could be the most affected by climate change. Estimates indicate that many species could lose close to 50% of their distribution ranges (Ureta et al. 2018). In addition to this factor, the rise in sea level due to the effects of climate change would affect many of the reptiles on islands (Bellard et al. 2013; Pliego-Sánchez et al. 2021). Although the effects of climate change on amphibians in the Baja California Peninsula have not been evaluated, we realize that changes in temperature on a global scale also will have strong effects on amphibians. These changes could affect reproduction and hibernation periods, as well as their ability to find food, alter pathogen-host dynamics, lead to increased stress from UV radiation, as well as alterations in reproduction and hibernation periods (Blaustein et al. 2010).

Species that inhabit elevations above 500 m are expected to lose a significant part of their climatically suitable area (Alves-Ferreira et al. 2022). Conversely, species that inhabit arid environments tend to expand their ranges in response to climate change. This result can be explained by the environmental characteristics of these habitats, which tend to have extreme seasonal climates with well-defined periods of drought and rain (Alves-Ferreira et al. 2022). Although the Cape Region in Baja California Sur is not particularly diverse in amphibian species, some predictions also indicate a reduction in the number of species that inhabit tropical dry forest (Ballesteros-Barrera et al. 2022).

Conservation Status

We used the three systems of conservation assessment that were used in the previous entries in the Mexican Conservation Series (MCS; see above). These systems are SEMARNAT (2019), the IUCN Red List (http://iucnredlist.org), and the EVS (Wilson et al. 2013a,b). Based on the features of the Baja California Peninsula system, we updated the assessments from these three systems as necessary.

The SEMARNAT List of Threatened Species

The Mexican Federal Government designates threatened species on the NOM-059-SEMARNAT-2010 listing. Species are classified through a risk assessment method developed by the Secretaria del Medio Ambiente y Recursos Naturales, with the last update published in 2019 (SEMARNAT 2019). The available ratings from this list are provided in Table 7 and summarized in

Table 10. SEMARNAT categorizations for the herpetofaunal species in the Baja California Peninsula, Mexico, arranged by family. Non-native species are excluded.

Family	Number of species	SEMARNAT categorization			
		Endangered (P)	Threatened (A)	Special Protection (Pr)	No Status (NS)
Bufonidae	6	—	1	—	5
Hylidae	2	—	—	—	2
Ranidae	3	1	—	2	—
Scaphiopodidae	2	—	—	—	2
Subtotal	**13**	**1**	**1**	**2**	**9**
Plethodontidae	3	—	—	2	1
Subtotal	**3**	—	—	**2**	**1**
Total	**16**	**1**	**1**	**4**	**10**
Anguidae	5	—	—	2	3
Anniellidae	2	—	—	2	—
Bipedidae	1	—	—	1	—
Crotaphytidae	5	—	—	1	4
Eublepharidae	3	—	—	1	2
Iguanidae	7	—	3	2	2
Phrynosomatidae	30	1	10	6	13
Phyllodactylidae	5	—	1	4	—
Scincidae	3	—	—	2	1
Teiidae	13	—	4	5	4
Xantusiidae	4	—	—	—	4
Subtotal	**78**	**1**	**18**	**26**	**33**
Charinidae	1	—	1	—	—
Colubridae	29	—	7	5	17
Dipsadidae	7	—	—	2	5
Elapidae	1	—	—	—	1
Leptotyphlopidae	2	—	—	—	2
Natricidae	4	—	3	—	1
Viperidae	12	—	2	8	2
Subtotal	**56**	—	**13**	**15**	**28**
Cheloniidae	4	4	—	—	—
Dermochelyidae	1	1	—	—	—
Emydidae	2	—	—	—	2
Testudinidae	1	—	1	—	—
Subtotal	**8**	**5**	**1**	—	**2**
Total	**142**	**6**	**32**	**41**	**63**
Sum Total	**158**	**7**	**33**	**45**	**73**

Table 10, and non-designated species are not included on the NOM-059-SEMARNAT-2010 list. This system utilizes three categories of assessment: endangered (P), threatened (A), and under special protection (Pr), and non-designated species are indicated here by using a "no status" (NS) category.

The data in Table 10 show that 85 (53.8%) of the 158 native species inhabiting the Baja California Peninsula and its adjacent islands are included in NOM-059 SEMARNAT, whereas 73 (46.2%) are not included, which could indicate either that they have not been assessed or are not considered as threatened.

In all MCS studies, the question always arises as to whether any bias is shown toward the conservation assessments of endemic species as opposed to non-endemic species using the SEMARNAT system, inasmuch as the majority of the species in a given area examined, in this case the Baja California Peninsula and its adjacent islands, remain unassessed. In order to answer this question, the pertinent data are shown in Table 11. These data show that about one-half of the non-endemic species (42, or 51.9% of 81 total species) remain unassessed, while a slightly lower number were unassessed for the peninsular endemics (31, or 40.3% of 77 total species). For the total native herpetofauna, 74, or 46.8% of 158 species, remain unassessed. Thus, no clear bias is apparent toward the peninsular endemics.

The IUCN System

The implementation of the system of conservation assessment established by the International Union for the Conservation of Nature has not kept pace with new species descriptions and ongoing taxonomic research. In fact, this is why the EVS system was developed—i.e., to assist in the development of conservation strategies when the IUCN system has not been applied. The data for the IUCN categorizations are shown in Table 8 and summarized in Table 12.

Of the 158 native species in the herpetofauna of the Baja California Peninsula, 130 (82.3%) have been evaluated under the IUCN system (Table 12). Of these

Table 11. Comparison of SEMARNAT and distributional categorizations for the Baja California Peninsula herpetofauna. Non-native species are excluded.

Distributional category	SEMARNAT category				
	Endangered (P)	**Threatened (A)**	**Special Protection (Pr)**	**No Status (NS)**	**Total**
Non-endemic Species (NE)	7	13	19	42	**81**
Peninsular endemic Species (PE)	—	20	26	31	**77**
Total	**7**	**33**	**45**	**73**	**158**

130 species, 15 (11.5%) have been placed in one of the three "threat categories," including three in the CR category, four in the EN category, and eight in the VU category. The three species in the CR category are the snake *Crotalus catalinensis*, a peninsular endemic species; and the turtles *Eretmochelys imbricata* and *Dermochelys coriacea*, both non-endemic marine species. The four species in the EN category are the anuran *Anaxyrus californicus*, a non-endemic species; the lizards *Anniella geronimensis* and *Sauromalus hispidus*, both peninsular endemic species; and the turtle *Chelonia mydas*, a non-endemic marine species. The eight VU species are the lizards *Sauromalus klauberi*, *Uta encantadae*, *U. lowei*, *U. tumidarostra*, *Aspidoscelis catalinensis*, and *A. labialis*, all peninsular endemic species, and the turtles *Lepidochelys olivacea* and *Actinemys pallida*, both non-endemic species.

Of the 115 species placed in the "lower risk categories"

Table 12. IUCN Red List categorizations for herpetofaunal families in the Baja California Peninsula, Mexico. Non-native species are excluded. Shaded columns to the left are the "threat categories," and those to the right are the categories for which too little information on conservation status exists to allow the taxa to be placed in any other IUCN category, or they have not been evaluated.

Family	Number of species	IUCN Red List categorization						
		Critically Endangered	**Endangered**	**Vulnerable**	**Near Threatened**	**Least Concern**	**Data Deficient**	**Not Evaluated**
Bufonidae	6	—	1	—	—	5	—	—
Hylidae	2	—	—	—	—	2	—	—
Ranidae	3	—	—	—	2	1	—	—
Scaphiopodidae	2	—	—	—	1	1	—	—
Subtotal	**13**	**—**	**1**	**—**	**3**	**9**	**—**	**—**
Plethodontidae	3	—	—	—	—	3	—	—
Subtotal	**3**	**—**	**—**	**—**	**—**	**3**	**—**	**—**
Total	**16**	—	**1**		**3**	**12**	—	—
Anguidae	5	—	—	—	—	5	—	—
Anniellidae	2	—	1	—	—	—	—	1
Bipedidae	1	—	—	—	—	1	—	—
Crotaphytidae	5	—	—	—	—	5	—	—
Eublepharidae	3	—	—	—	—	3	—	—
Iguanidae	7	—	1	1	1	3	—	1
Phrynosomatidae	30	—	—	3	2	24	—	1
Phyllodactylidae	5	—	—	—	1	4	—	—
Scincidae	3	—	—	—	—	3	—	—
Teiidae	13	—	—	2	—	10	—	1
Xantusiidae	4	—	—	—	—	1	—	3
Subtotal	**78**	**—**	2	**6**	4	**59**	—	**7**
Charinidae	1	—	—	—	—	1	—	—
Colubridae	29	—	—	—	—	18	3	8
Dipsadidae	7	—	—	—	—	4	—	3
Elapidae	1	—	—	—	—	1	—	—
Leptotyphlopidae	2	—	—	—	—	1	—	1
Natricidae	4	—	—	—	—	4	—	—
Viperidae	12	1	—	—	—	7	—	4
Subtotal	**56**	**1**	**—**	**—**	**—**	**36**	**3**	**16**
Cheloniidae	4	1	1	1	—	1	—	—
Dermochelyidae	1	1	—	—	—	—	—	—
Emydidae	2	—	—	1	—	—	—	1
Testudinidae	1	—	—	—	—	—	—	1
Subtotal	**8**	**2**	**1**	**2**	**—**	**1**	**—**	**1**
Total	**142**	**3**	**3**	**8**	**4**	**96**	**3**	**25**
Sum total	**158**	**3**	**4**	**8**	**7**	**108**	**3**	**25**
Category total	**158**	**15**			**115**		**28**	

(NT and LC), only seven are in the NT category, with the remaining 108 species in the LC category (Table 12). The seven NT species are the anurans *Rana draytonii*, *Rana boylii*, and *Spea hammondii*; all non-endemic species, and the lizards are *Sauromalus slevini*, *Phrynosoma mcallii*, *Uma notata*, and *Phyllodactylus unctus*, which include two peninsular endemic species and two non-endemic species. The 108 LC species make up 68.4% of the 158 native species in the Baja California Peninsula. Finally, 28 species have not been assessed using the IUCN system, including three allocated to the DD category. These 28 species comprise 17.7% of the native species, and their assessments using the EVS system are given below.

The EVS System

As discussed in all the earlier MCS studies, the Environmental Vulnerability System (EVS) initially was developed for use in the conservation evaluation of the herpetofauna in the country of Honduras (Wilson and McCranie 2004). Those authors created this system as a means for determining the conservation status of the members of a herpetofauna whose knowledge was insufficient when using the IUCN system. When the work of the MCS began in 2013, it was evident that the EVS could be applied to the Mexican herpetofauna just as easily as it had for the Honduran herpetofauna. Subsequently, this system has been employed in all of the MCS studies to date (see above), including the present one. Thus, the EVS values for the 152 native non-marine species of the Baja California Peninsula are shown in Table 8 and summarized in Table 13.

The EVS values range from 3 to 20. The most frequent values (applied to 10 or more species) are 9 (11), 10 (10), 11 (15), 12 (14), 14 (15), 15 (15), 16 (18), and 17 (29). Collectively, these eight values were applied to 127 of the 152 native non-marine species (83.6%). The lowest score of 3 was ascertained for two anuran species (*Scaphiopus couchii* and *Anaxyrus punctatus*) and the highest score of 20 was assigned to the Todos Santos Island Kingsnake (*Lampropeltis herrerae*).

The EVS scores are grouped into three categories

Table 13. Environmental Vulnerability Scores (EVS) for the herpetofaunal species in the Baja California Peninsula, Mexico, arranged by family. The shaded area to the left encompasses low vulnerability scores, and the one to the right high vulnerability scores. Non-native species are excluded.

Family	Number of species	Environmental Vulnerability Scores																	
		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Bufonidae	6	1	1	—	—	1	—	—	1	2	—	—	—	—	—	—	—	—	—
Hylidae	2	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—
Ranidae	3	—	—	—	—	—	—	—	—	1	2	—	—	—	—	—	—	—	—
Scaphiopodidae	2	1	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Subtotal	**13**	**2**	**1**	—	—	**1**	—	**1**	**1**	**5**	**2**	—	—	—	—	—	—	—	—
Plethodontidae	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	**3**	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	**16**	**2**	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Anguidae	5	—	—	—	—	—	—	—	1	—	—	—	1	1	2	—	—	—	—
Anniellidae	2	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—
Bipedidae	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	
Crotaphytidae	5	—	—	—	—	—	—	1	—	1	1	—	—	—	2	—	—	—	—
Eublepharidae	3	—	—	—	—	—	—	1	1	—	—	—	—	—	1	—	—	—	—
Iguanidae	7	—	—	—	—	—	—	—	—	—	1	1	1	—	2	2	—	—	—
Phrynosomatidae	30	—	—	1	—	2	—	2	1	1	4	2	4	3	3	7	—	—	—
Phyllodactylidae	5	—	—	—	—	—	—	—	1	—	—	—	—	2	1	1	—	—	—
Scincidae	3	—	—	—	—	—	—	—	1	1	—	1	—	—	—	—	—	—	—
Teiidae	13	—	—	—	—	—	1	—	1	—	—	—	1	1	2	7	—	—	—
Xantusiidae	4	—	—	—	—	—	—	—	—	2	—	—	—	2	—	—	—	—	—
Subtotal	**78**	**0**	**0**	**1**	**0**	**2**	**1**	**4**	**6**	**6**	**6**	**4**	**8**	**9**	**13**	**17**	**0**	**1**	**0**
Charinidae	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
Colubridae	29	—	—	1	1	1	4	3	—	2	4	1	3	3	1	3	1		1
Dipsadidae	7	—	1	—	—	—	—	—	2	1	—	—	—	—	3	—	—	—	—
Leptotyphlopidae	2	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—
Natricidae	4	—	—	—	—	—	—	1	—	1	1	—	1	—	—	—	—	—	—
Viperidae	12	—	—	—	—	—	—	2	—	—	1	2	—	1	1	—	1	4	—
Subtotal	**55**	**0**	**1**	**1**	**1**	**1**	**5**	**6**	**3**	**4**	**6**	**3**	**5**	**4**	**5**	**3**	**2**	**4**	**1**
Emydidae	2	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—
Testudinidae	1	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Subtotal	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**2**	**0**	**0**	**0**	**0**	**0**
Total	**136**	**0**	**1**	**2**	**1**	**3**	**6**	**10**	**9**	**10**	**12**	**8**	**13**	**15**	**18**	**20**	**2**	**5**	**1**
Sum total	**152**	**2**	**2**	**2**	**1**	**4**	**6**	**11**	**10**	**15**	**14**	**9**	**15**	**15**	**18**	**20**	**2**	**5**	**1**
Category total	**152**	**28**							**48**				**76**						

Table 14. Comparison of Environmental Vulnerability Scores (EVS) and IUCN categorizations for members of the herpetofauna of the Baja California Peninsula, Mexico. Non-native species are excluded. The shaded area at the top encompasses low vulnerability scores, and the one at the bottom high vulnerability scores.

EVS	IUCN category							Total
	Critically Endangered	Endangered	Vulnerable	Near Threatened	Least Concern	Data Deficient	Not Evaluated	
3	—	—	—	—	2	—	—	2
4	—	—	—	—	2	—	—	2
5	—	—	—	—	2	—	—	2
6	—	—	—	—	1	—	—	1
7	—	—	—	—	4	—	—	4
8	—	—	—	—	5	—	1	6
9	—	—	—	—	10	—	1	11
10	—	—	—	—	9	—	1	10
11	—	1	—	2	10	—	2	15
12	—	—	—	1	10	—	3	14
13	—	—	1	—	7	—	1	9
14	—	2	—	—	8	—	5	15
15	—	—	1	3	5	—	6	15
16	—	—	—	1	15	—	2	18
17	—	—	5	—	12	2	1	20
18	—	—	—	—	1	1	—	2
19	1	—	—	—	2	—	2	5
20	—	—	—	—	1	—	—	1
Total	**1**	**3**	**7**	**7**	**106**	**3**	**25**	**152**

of low, medium, and high vulnerability. As a result, the summary values (Table 13) increase from low vulnerability (28 species) to medium vulnerability (48 species), and then to high vulnerability (76 species). Typically, this pattern is characteristic of herpetofaunas containing more endemic than non-endemic species, although this is not the case with the herpetofauna of the Baja California Peninsula, in which there are 83 non-endemic species and 75 endemic species. However, this pattern could be due to the high level of island endemics that have high vulnerability values.

The numbers of species in the herpetofauna of the Baja California Peninsula for each IUCN/EVS score combination are shown in Table 14. These data illustrate that although both systems agree on the low vulnerability category and Least Concern category for 26 species (17%), they differ in the remaining categories, as only 11 of the 76 high vulnerability species (14.5%) are placed into one of the three IUCN "threat categories" (CR, EN, or VU). As was found in all other MCS studies, the results of the application of the IUCN and EVS systems of conservation assessment do not correspond well with one another.

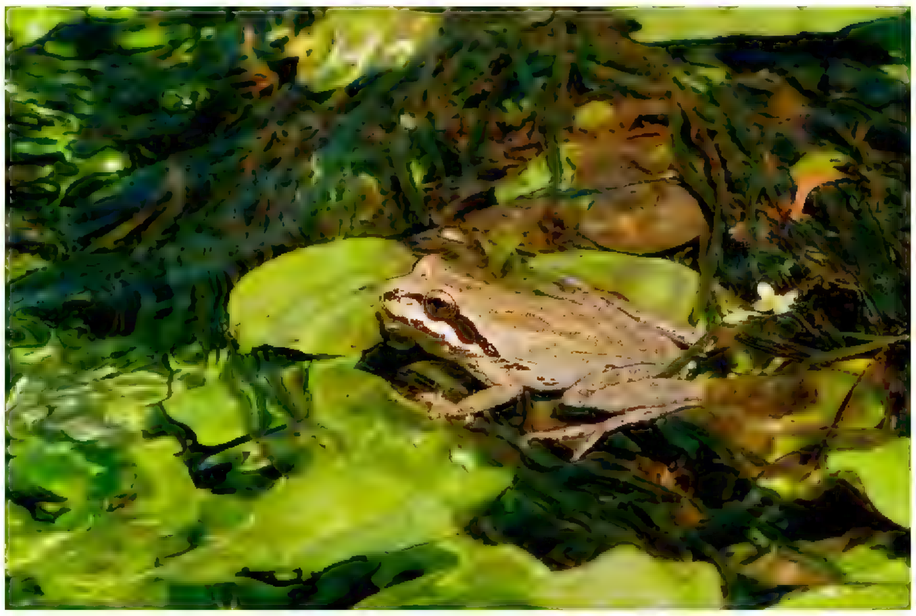
Of the 152 species that can be assessed by both the IUCN and EVS systems, only three have been allocated to the IUCN DD category (Table 15). These are three peninsular endemic snake species (*Lampropeltis catalinensis*, *Masticophis barbouri*, and *Rhinocheilus etheridgei*), which have respective EVS scores of 18, 17, and 17. Based on the arguments presented in previous MCS studies, we suggest that once these species are evaluated by the IUCN, they should be relegated to the CR (*Lampropeltis catalinensis*) and EN (*Rhinocheilus etheridgei* and *Masticophis barbouri*) categories.

Twenty-five species (15.8% of the 158 native species) have not been evaluated by the IUCN system. These 25 species include seven lizards, 16 snakes, and two turtles. The majority of these species (15 of 25, or 60.0%) are peninsular endemics, and the remainder (10, or 40%) are non-endemics. These species are allocated to the three EVS categories of vulnerability as follows: two low (8.0%); seven medium (28.0%); and 16 high (64.0%). Based on the vulnerability values, species with an EVS of 17 and greater might be placed in the CR category;

Table 15. Environmental Vulnerability Scores (EVS) for members of the herpetofauna of the Baja California Peninsula, Mexico, that are allocated to the IUCN Data Deficient category. ** = peninsular endemic.

Taxon	Environmental Vulnerability Score (EVS)			
	Geographic distribution	Ecological distribution	Reproductive mode/ Degree of persecution	Total score
*Lampropeltis catalinensis***	6	8	4	18
*Masticophis barbouri***	5	8	4	17
*Rhinocheilus etheridgei***	6	8	3	17

No. 1. *Anaxyrus californicus* (Camp, 1915). The Arroyo Toad is found "west of the deserts in southern California (USA) near Santa Margarita in San Luis Obispo County south into northern Baja California (Mexico), at least as far south as Arroyo San Simón, just south of San Quintín" (Frost 2022). This individual came from Rancho Meling, Sierra San Pedro Mártir, in the municipality of San Quintín. In this study its EVS was estimated as 11, placing it in the upper portion of the medium vulnerability category. The IUCN has assessed its conservation status as Endangered (EN) and SEMARNAT lists it as Threatened (A). *Photo by Ivan Parr.*



No. 2. *Pseudacris hypochondriaca* (Hallowell, 1854). The Baja California Chorus Frog ranges from "southern California, western and southwestern Nevada, and adjacent northwestern Arizona (Mohave County) south to the southern tip of Baja California peninsula, Mexico" (Frost 2022). This individual was found at Rancho Meling, Sierra San Pedro Mártir, in the municipality of San Quintín. In this study its EVS was determined as 9, placing it at the upper limit of the low vulnerability category. This species has not been evaluated by the IUCN or SEMARNAT. *Photo by Jorge H. Valdez-Villavicencio.*

No. 3. *Rana draytonii* (Baird and Girard, 1852). The California Red-legged Frog is distributed from "Mendocino County (California, USA) south along the Pacific coast of the USA to the vicinity of Arroyo Santo Domingo in northern Baja California (Mexico)" (Frost 2022). This individual was found at Rancho Meling, Sierra San Pedro Mártir, in the municipality of San Quintín. In this study its EVS was indicated as 11, placing it in the medium vulnerability category. The IUCN evaluated its status as Near Threatened (NT), and this species is listed by SEMARNAT as in danger of extinction (P). *Photo by J.A. Soriano.*

No. 4. *Aneides lugubris* (Hallowell, 1849). The Arboreal Salamander ranges "from sea level to near 1,270 m in elevation and ranges from Eureka in Humboldt County, California, south through the Coast Ranges, terminating near Valle Santo Tomás in northwestern Baja California. It also occurs on the Coronado Norte island" (Grismer 2002: 56). This individual came from La Misión, Baja California, in the municipality of Ensenada. In this study its EVS is listed as 14, placing it at the lower limit of the high vulnerability category. The IUCN judged its conservation status as Least Concern (LC), and SEMARNAT lists it as a species of Special Protection (Pr). *Photo by Jorge H. Valdez-Villavicencio.*

Table 16. Environmental Vulnerability Scores (EVS) for members of the herpetofauna of the Baja California Peninsula, Mexico, that are currently not evaluated (NE) by the IUCN. Non-native taxa are excluded. ** = peninsular endemic.

Taxon	Environmental Vulnerability Score (EVS)			
	Geographic distribution	Ecological distribution	Reproductive mode/ Degree of persecution	Total score
Anniella stebbinsi	4	6	1	11
*Dipsosaurus catalinensis***	6	8	3	17
*Phrynosoma cerroense***	5	6	3	14
*Aspidoscelis maximus***	5	6	3	14
*Xantusia gilberti***	5	8	2	15
*Xantusia sherbrookei***	5	8	2	15
Xantusia wigginsi	2	7	2	11
Lampropeltis multifasciata	2	7	5	14
Masticophis fuliginosus	2	3	4	9
Sonora annulata	4	8	2	14
*Sonora cincta***	2	4	2	8
*Sonora fasciata***	5	5	2	12
*Sonora mosaueri***	5	5	2	12
*Sonora punctatissima***	5	8	2	15
*Sonora straminea***	5	8	2	15
*Hypsiglena catalinae***	6	8	2	16
*Hypsiglena marcosensis***	6	8	2	16
Hypsiglena ochrorhynchus	4	4	2	10
*Rena boettgeri***	5	8	1	14
Crotalus helleri	4	3	5	12
*Crotalus polisi***	6	8	5	19
Crotalus pyrrhus	4	4	5	13
*Crotalus thalassoporus***	6	8	5	19
*Trachemys nebulosa***	5	7	3	15
Gopherus morafkai	4	5	6	15

which includes *Dipsosaurus catalinensis* (17), *Crotalus polisi* (19), and *C. thalassoporus* (19). All three of these species are peninsular endemics. Vulnerability values of 15 and 16 can be allocated to the EN category, including *Gopherus morafkai* (15), *Xantusia gilberti* (15), *X. sherbrookei* (15), *Sonora punctatissima* (15), *Sonora straminea* (15), *Trachemys nebulosa* (15), *Hypsiglena catalinae* (16), and *Hypsiglena marcosensis* (16). All but one of these species (*G. morafkai*) are peninsular endemics. Species with an EVS of 14 could be placed in the VU category, including *Phrynosoma cerroense, Aspidoscelis maximus, Lampropeltis multifasciata, Sonora annulata*, and *Rena boettgeri*. The first of these two species and the last one are peninsular endemics. The species with an EVS of 10 to 13 can be allocated to the NT category, including *Anniella stebbinsi* (11), *Xantusia wigginsi* (11), *Sonora fasciata* (12), *Sonora mosaueri* (12), *Hypsglena ochrorhynchus* (10), *Crotalus helleri* (12), and *C. pyrrhus* (13). Only two of these seven species (*S. fasciata* and *S. mosaueri*) are peninsular endemics. Finally, the two species with an EVS of 3 to 9 can be placed in the LC category (*Sonora cincta* and *Masticophis fuliginosus*).

The largest number of species in the Baja California Peninsula herpetofauna that can be assigned an EVS are placed in the IUCN LC category (106 species; see Table 17), even though their EVS values range from 3 to 20, the range found in the entire herpetofauna of the Baja California Peninsula, as well as the entire theoretical EVS range. Of these 106 species, 47 (44.3%) are peninsular endemics, and the remaining 59 (55.7%) are non-endemics. As indicated in the above paragraphs dealing with the NE species, we suggest that the species with EVS scores of 3 to 9 might be allocated to the LC category, 10 to 13 to the NT category, 14 to the VU category, 15 and 16 to the EN category, and 17 to 20 to the CR category. Accordingly, the following species numbers might be placed in the IUCN categories as follows: LC (26), NT (36), VU (8), EN (20), and CR (16). We recognize that the EVS values will not always correspond with IUCN or SEMARNAT categories. The IUCN and EVS categories evaluate the population along the entire distribution of the species. As for the SEMARNAT system, it only lists threatened species, so species with EVS values lower than 9 are not expected to appear in the NOM-059-SEMARNAT 2010. It remains unknown, however, whether their omission is due to a lack of evaluation or because their populations are not threatened.

In general, the EVS values for amphibians are assigned lower values, with only two of the 16 native species scoring in the high vulnerability category (14 or higher). The two amphibians with high values are the

No. 5. *Batrachoseps major* Camp, 1915. The Garden Slender Salamander is distributed from "Los Angeles County south to the vicinity of El Rosario in northwestern Baja California. It also occurs on the Pacific islands Coronado (Norte, Medio, and Sur), and Todos Santos Sur" (Grismer 2002: 58). This individual was found at Rancho Las Dos Cumbres, Tecate, Baja California, in the municipality of Tecate. In this study its EVS was calculated as 14, placing it at the lower limit of the high vulnerability category. The IUCN assigned this salamander to the Least Concern (LC) category, but this species is not listed by SEMARNAT. *Photo by Anny Peralta-García.*

No. 6. *Ensatina eschscholtzii* Gray, 1850. The Monterey Salamander "ranges along the Pacific coast of North America from southwestern British Columbia south to at least 22 km south of Ensenada in northwestern Baja California" (Grismer 2002: 60; Peralta-García and Valdez-Villavicencio 2004). This individual came from La Misión, Baja California, in the municipality of Ensenada. The species EVS was estimated as 13, placing it at the higher limit of the medium vulnerability category. The IUCN assessed its conservation status as Least Concern (LC), and SEMARNAT considers it as a species of Special Protection (Pr). *Photo by Jorge H. Valdez-Villavicencio.*

No. 7. *Elgaria nana* (Fitch, 1934). The Islas Coronado Alligator Lizard is known from all the islands of the Islas Coronado archipelago on the coast of northwestern Baja California. This individual was encountered on Isla Coronado Sur, Baja California, in the municipality of Tijuana. In this study its EVS was determined as 16, placing it in the middle portion of the high vulnerability category. The IUCN assessed its conservation status as Least Concern (LC), and it is not listed by SEMARNAT. *Photo by Jorge H. Valdez-Villavicencio.*

No. 8. *Elgaria paucicarinata* (Fitch, 1934). The San Lucan Alligator Lizard "is restricted to the mountains and foothill regions of the Cape Region of Baja California" (Grismer 2002: 248). This individual came from Arroyo La Junta, Sierra La Laguna, Baja California Sur, in the municipality La Paz. In this study its EVS is indicated as 14, placing it at the lower limit of the high vulnerability category. The IUCN assessed its conservation status as Least Concern (LC), and SEMARNAT designates it as a species of Special Protection (Pr). *Photo by Jorge H. Valdez-Villavicencio.*

Table 17. Environmental Vulnerability Scores (EVS) for members of the herpetofauna of the Baja California Peninsula, Mexico, that are assigned to the IUCN Least Concern (LC) category. Non-native and marine taxa are not included. ** = peninsular endemic.

Taxon	Environmental Vulnerability Score (EVS)			
	Geographic distribution	Ecological distribution	Reproductive mode/ Degree of persecution	Total score
Anaxyrus boreas	2	4	1	7
Anaxyrus cognatus	1	2	1	4
Anaxyrus punctatus	1	1	1	3
Anaxyrus woodhousii	3	6	1	10
Incilius alvarius	4	6	1	11
Pseudacris cadaverina	4	6	1	11
Pseudacris hypochondriaca	4	4	1	9
Lithobates yavapaiensis	4	7	1	12
Scaphiopus couchii	1	1	1	3
Aneides lugubris	3	7	4	14
Batrachoseps major	4	6	4	14
Ensatina eschscholtzii	3	6	4	13
*Elgaria cedrosensis***	5	8	3	16
Elgaria multicarinata	3	4	3	10
*Elgaria nana***	5	8	3	16
*Elgaria paucicarinata***	5	6	3	14
*Elgaria velazquezi***	5	7	3	15
*Bipes biporus***	5	8	6	19
*Crotaphytus grismeri***	5	8	3	16
*Crotaphytus insularis***	5	8	3	16
Crotaphytus vestigium	2	4	3	9
*Gambelia copeii***	2	6	3	11
Gambelia wislizenii	3	6	3	12
*Coleonyx gypsicolus***	6	8	2	16
Coleonyx switaki	2	6	2	10
Coleonyx variegatus	4	3	2	9
*Ctenosaura hemilopha***	5	7	4	16
Dipsosaurus dorsalis	4	5	3	12
Sauromalus ater	4	6	3	13
Callisaurus draconoides	4	5	3	12
Petrosaurus mearnsi	2	5	3	10
*Petrosaurus repens***	5	6	3	14
*Petrosaurus slevini***	5	8	3	16
*Petrosaurus thalassinus***	5	6	6	17
Phrynosoma blainvillii	3	6	3	12
*Phrynosoma coronatum***	5	4	3	12
Phrynosoma platyrhinos	3	7	3	13
*Sceloporus angustus***	5	8	3	16
*Sceloporus grandaevus***	6	8	3	17
*Sceloporus hunsakeri***	5	6	3	14
*Sceloporus licki***	5	5	3	13
*Sceloporus lineatulus***	6	8	3	17
Sceloporus magister	1	5	3	9
Sceloporus occidentalis	3	5	3	11
Sceloporus orcutti	2	2	3	7
Sceloporus vandenburgianus	4	7	3	14
*Sceloporus zosteromus***	5	4	3	12
Urosaurus graciosus	4	8	3	15
*Urosaurus lahtelai***	5	8	3	16
Urosaurus nigricaudus	2	2	3	7
Urosaurus ornatus	1	5	3	9
*Uta squamata***	6	8	3	17
Uta stansburiana	1	1	3	5
*Phyllodactylus bugastrolepis***	6	8	3	17

Table 17 (continued). Environmental Vulnerability Scores (EVS) for members of the herpetofauna of the Baja California Peninsula, Mexico, that are assigned to the IUCN Least Concern (LC) category. Non-native and marine taxa are not included. ** = peninsular endemic.

Taxon	Environmental Vulnerability Score (EVS)			
	Geographic distribution	Ecological distribution	Reproductive mode/ Degree of persecution	Total score
Phyllodactylus nocticolus	2	5	3	10
*Phyllodactylus partidus***	5	8	3	16
*Phyllodactylus xanti***	5	7	3	15
Plestiodon gilberti	3	6	2	11
*Plestiodon lagunensis***	5	6	2	13
Plestiodon skiltonianus	3	5	2	10
*Aspidoscelis canus***	6	8	3	17
*Aspidoscelis carmenensis***	6	8	3	17
*Aspidoscelis celeripes***	5	8	3	16
*Aspidoscelis ceralbensis***	6	8	3	17
*Aspidoscelis danheimae***	6	8	3	17
*Aspidoscelis espiritensis***	5	8	3	16
*Aspidoscelis franciscensis***	6	8	3	17
Aspidoscelis hyperythrus	2	5	3	10
*Aspidoscelis pictus***	6	8	3	17
Aspidoscelis tigris	3	2	3	8
Xantusia henshawi	4	5	2	11
Lichanura trivirgata	4	3	3	10
Arizona elegans	1	1	3	5
*Arizona pacata***	5	6	3	14
Bogertophis rosaliae	2	5	4	11
Lampropeltis californiae	4	1	4	9
*Lampropeltis herrerae***	6	8	6	20
*Masticophis aurigulus***	5	6	4	15
Masticophis flagellum	1	3	4	8
Masticophis lateralis	3	5	4	12
Phyllorhynchus decurtatus	4	5	3	12
Pituophis catenifer	1	1	5	7
*Pituophis insulanus***	6	6	5	17
*Pituophis vertebralis***	5	3	5	13
Rhinocheilus lecontei	1	3	4	8
Salvadora hexalepis	4	2	3	9
*Sonora savagei***	6	8	2	16
Sonora semiannulata	3	1	2	6
Tantilla planiceps	2	3	3	8
Trimorphodon lyrophanes	2	4	5	11
Diadophis punctatus	1	1	2	4
Hypsiglena chlorophaea	3	5	2	10
*Hypsiglena gularis***	6	8	2	16
*Hypsiglena slevini***	5	4	2	11
Rena humilis	4	3	1	8
Thamnophis elegans	3	8	3	14
Thamnophis hammondii	4	5	3	12
Thamnophis marcianus	1	5	3	9
*Thamnophis validus***	5	3	3	11
*Crotalus angelensis***	6	7	5	18
Crotalus atrox	1	3	5	9
Crotalus cerastes	4	7	5	16
*Crotalus enyo***	5	3	5	13
*Crotalus lorenzoensis***	6	8	5	19
*Crotalus mitchellii***	5	5	5	15
Crotalus ruber	2	2	5	9

No. 9. *Anniella geronimensis* Shaw, 1940. The Baja California Legless Lizard "ranges along the coastal aeolian dune regions of northwestern Baja California, from approximately 6 km north of Colonia Guerrero south to just south of Punta Baja at the northern edge of Bahía El Rosario. It is also known from the Pacific islands of San Gerónimo and San Martín." (Grismer 2002: 242). This individual was encountered at San Quintín, Baja California, in the municipality of San Quintín. In this study its EVS is noted as 14, placing it at the lower limit of the high vulnerability category. The IUCN judged its conservation status as Endangered (EN), and SEMARNAT lists it as a species of Special Protection (Pr). *Photo by Jorge H. Valdez-Villavicencio.*

No. 10. *Bipes biporus* (Cope, 1894). The Five-toed Worm Lizard is distributed "throughout the western portion of the southern half of Baja California peninsula, west of the Peninsular Ranges, from approximately 17 km north of Jesús María, where the Sierra Columbia contacts the Pacific coast, south to Todos Santos (Mahrdt et al. 2022)…At the Isthmus of La Paz, its distribution extends east across the low, sandy flats and contacts the Gulf coast at Bahía de La Paz" (Grismer 2002: 254). It also occurs on the Pacific island of Magdalena (Peralta-García et al. 2007). This individual was found at La Paz, Baja California Sur, in the municipality of La Paz. In this study its EVS was determined as 19, placing it near the higher limit of the high vulnerability category. The IUCN assessed its conservation status as Least Concern (LC), and SEMARNAT designates it as a species of Special Protection (Pr). *Photo by Jorge H. Valdez-Villavicencio.*

No. 11. *Crotaphytus insularis* Van Denburgh and Slevin, 1921. The Isla Ángel de la Guarda Collared Lizard is endemic to Isla Ángel de la Guarda in the Gulf of California in the municipality of Mexicali (Grismer 2002). Its EVS was assessed as 16, placing it in the middle of the high vulnerability category. The IUCN evaluated its conservation status as Least Concern (LC), but this lizard is not listed by SEMARNAT. *Photo by Jorge H. Valdez-Villavicencio.*

No. 12. *Gambelia copeii* (Yarrow, 1882). The Baja California Leopard Lizard "is endemic to Baja California peninsula and ranges from extreme southern San Diego County, California, south to at least Todos Santos on the west coast of the Cape Region" (Grismer 2002: 114). This individual came from 20 km NW of San Juanico, Baja California Sur, in the municipality of Comondú. In this study its EVS was estimated as 11, placing it in the lower portion of the medium vulnerability category. The IUCN judged its conservation status as Least Concern (LC), but this species is not listed by SEMARNAT. *Photo by Jorge H. Valdez-Villavicencio.*

No. 13. *Coleonyx switaki* (Murphy, 1974). Switak's Banded Gecko "ranges along the desert foothills of the Peninsular Ranges from at least northern San Diego County, California, south to just north of Santa Rosalía" (Grismer 2002: 199) in Baja California Sur. This individual was located in San Ignacio, Baja California Sur, in the municipality of Mulegé. In this study its EVS is noted as 10, placing it at the lower limit of the medium vulnerability category. The IUCN determined its conservation status as Least Concern (LC), but this gecko is not listed by SEMARNAT. *Photo by Tim Warfel*.

No. 14. *Ctenosaura hemilopha* (Cope, 1863). The Cape Spiny-tailed Iguana "ranges from near Loreto south along the Sierra la Giganta to the west coast near Arroyo Seco and through the Cape Region…In the Gulf of California, *C. hemilopha* is known only from Isla Cerralvo…" (Grismer 2002: 117). This individual came from Sierra La Gata, Baja California Sur, in the municipality of La Paz. In this study its EVS was calculated as 16, placing it in the middle portion of the high vulnerability category. The IUCN determined its conservation status as Least Concern (LC), but SEMARNAT considers it to be a species of Special Protection (Pr). *Photo by Jorge H. Valdez-Villavicencio.*

No. 15. *Sauromalus hispidus* Stejneger, 1891. The Spiny Chuckwalla "is known from the Gulf islands of Ángel de la Guarda, Cabeza de Caballo, Flecha, Granito, La Ventana, Mejía, Piojo, Pond, San Lorenzo Norte, San Lorenzo Sur, and Smith" (Grismer 2002: 128). This individual was found on Isla Ángel de la Guarda, Baja California, in the municipality of Mexicali. In this study its EVS was determined as 14, placing it at the lower limit of the high vulnerability category. The IUCN assessed its conservation status as Endangered (EN), and SEMARNAT noted it as Threatened (A). *Photo by Jorge H. Valdez-Villavicencio.*

No. 16. *Callisaurus draconoides* Blainville, 1835. The Zebra-tailed Lizard "ranges throughout the Sonoran and Mojave deserts of the southwestern United States and northern Mexico south to southern Sinaloa and all the arid regions of Baja California" (Grismer 2002: 136). This individual was encountered at Guerrero Negro, Baja California Sur, in the municipality of Mulegé. In this study its EVS is listed as 12, placing it in the upper portion of the medium vulnerability category. The IUCN assessed its conservation status as Least Concern (LC), and SEMARNAT designates it as Threatened (A). *Photo by Alan Harper.*

Table 18. Number of herpetofaunal species in three distributional status categories among the 10 physiographic regions of the Baja California Peninsula, Mexico. Rank was determined by adding the state and country endemics.

Geographic region	Distributional Status Category			Total	Rank order
	Non-endemic	Peninsular Endemic	Non-native		
CR	47	8	5	60	7
LCVR	59	5	4	68	8
BCCFR	27	—	—	27	9
VR	43	18	3	64	5
CGCR	35	24	3	62	3
MR	32	18	1	51	5
ATR	32	26	7	65	2
SLLR	18	21	2	41	4
PIR	32	15	—	47	6
GIR	32	50	2	84	1

salamanders *Aneides lugubris* and *Batrachoseps major*, both with an EVS of 14 (Table 8). In Baja California, the major threats to amphibians are wetland habitat loss and the presence of exotic species. If regional specific criteria were considered in future EVS evaluations, vulnerability values for amphibians in this region likely would be higher and correspond more closely with those from other parts of Mexico.

Relative Herpetofaunal Priority

Johnson et al. (2015) introduced the concept of Relative Herpetofaunal Priority (RHP) as a simple means for measuring the relative importance of the herpetofaunal species in any geographic segment (e.g., state or physiographic region). Ascertaining the RHP involves the employment of two methods: (1) calculating the absolute number of state, country, or regional endemic species as they relate to the entire regional herpetofauna, and (2) calculating the absolute number of high EVS category species in the entire regional herpetofauna. The pertinent data for these two methods are shown in Tables 18 and 19.

Based on the relative number of peninsular endemics (Table 18), the 1st rank is held by the GIR with 50 peninsular endemics from a total of 84 species (59.5%). The remaining ranks are as follows: 2nd is ATR (26 of 65 species, 40.0%); 3rd is CGCR (24 of 62 species, 38.7%); 4th is SLLR (21 of 41 species, 51.2%); 5th (held by two regions) is MR (18 of 51 species, 35.3%) and VR (18 of 64 species, 28.1%); 6th is PIR (15 of 47 species, 31.9%); 7th is CR (eight of 60 species, 13.3%); 8th is LCVR (five of 68 species, 7.4%); and 9th is BCCFR (0 of 27 species, 0.0%).

Clearly, the highest herpetofaunal priority is associated with the Gulf Islands Region. This region consists of all the islands lying off the Baja California Peninsula and within the Gulf of California, excluding those more closely associated with the state of Sonora on the eastern side of the Gulf. Collectively, these islands harbor the largest number of species found in any of the geographic regions of Baja California. The number of species is 84, which is 48.8% of the total number (172) known from the entire peninsula and its adjacent islands. The herpetofauna of these islands is only one of two regional herpetofaunas in which the number of peninsular endemics exceeds that of the non-endemics. The other such region is the SLLR, in which the number of peninsular endemics (21) is greater than the number of non-endemics (18). In the Gulf region, the number of peninsular endemics is 1.6 times that of the non-endemics (50 vs. 32). The 50 peninsular endemics in the Gulf region include species that occupy from one to nine of the 10 recognized regions in the peninsula, as follows:

Table 19. Number of herpetofaunal species in the three EVS categories (low, medium, and high) among the 10 geographic regions of the Baja California Peninsula, Mexico. Rank determined by the relative number of high EVS species. Non-native and marine species are excluded.

Geographic region	Low	Medium	High	Total	Rank order
CR	19	29	5	53	9
LCVR	27	26	6	59	8
BCCFR	9	14	4	27	10
VR	20	28	10	58	5
CGCR	16	23	15	54	3
MR	15	21	9	45	7
ATR	15	22	16	53	2
SLLR	11	15	13	39	4
PIR	14	17	10	41	6
GIR	14	17	45	76	1

No. 17. *Petrosaurus repens* (Van Denburgh, 1895). The Short-nosed Rock Lizard ranges from Mesa San Carlos near the middle of Baja California southward to Arroyo Seco in the Isthmus of La Paz. This individual came from San Miguel Comondú, Baja California Sur. In this study its EVS was calculated as 14, placing it at the lower limit of the high vulnerability category. The IUCN determined its conservation status as Least Concern (LC), and it is not listed by SEMARNAT. *Photo by Jorge H. Valdez-Villavicencio.*

No. 18. *Petrosaurus thalassinus* (Cope, 1863). The San Lucan Banded Rock Lizard "is restricted to the Cape Region of Baja California, where it occurs in at least four disjunct populations: one in the Sierra La Laguna and contiguous ranges, another in the Sierra La Trinidad, and one each on the Gulf islands of Espíritu Santo and Partida Sur…" (Grismer 2002: 149). This individual was located at Sierra Las Cacachilas, Baja California Sur, in the municipality of La Paz. In this study its EVS was assessed as 17, placing it in the middle of the high vulnerability category. The IUCN evaluated its conservation status as Least Concern (LC), and SEMARNAT determined it to be a species of Special Protection (Pr). *Photo by Alan Harper.*

No. 19. *Phrynosoma blainvillii* Gray, 1839. Blainville's Horned Lizard ranges "west of the Sierra Nevada crest from Shasta County, California, south through all of southern California west of the Mojave and Sonoran deserts" (Grismer 2002: 151) and the extreme northwestern portion of Baja California. This individual was found on the road to Sierra Juárez, Baja California, in the municipality of Ensenada. In this study its EVS was calculated as 12, placing it in the middle of the medium vulnerability category. The IUCN evaluated its conservation status as Least Concern (LC), and it is not listed by SEMARNAT. *Photo by Jorge H. Valdez-Villavicencio.*

No. 20. *Phrynosoma coronatum* (Blainville, 1835). The Coast Horned Lizard ranges across the Cape Region of Baja California Sur and across the Magdalena Plain to the southern edge of the Vizcaíno Desert (Leaché et al. 2009). This individual was found in the Sierra Las Cacachilas, Baja California Sur, in the municipality of La Paz. In this study its EVS was assessed as 12, placing it in the upper portion of the medium vulnerability category. The IUCN judged its conservation status as Least Concern (LC), and it is not listed by SEMARNAT. *Photo by Jorge H. Valdez-Villavicencio.*

one (38 species, 76.0%); three (two species, 4.0%); four (two species, 4.0%); five (three species, 6.0%); seven (one species, 2.0%); eight (three species, 6.0%); and nine (one species, 2.0%).

Based on the relative number of high vulnerability species (Table 19), the 1st rank is held by the GIR (45 of 76 species, 59.2%), the same rank as for the relative number of country endemics (see above). The rankings are the same for seven of the 10 regions. The high vulnerability ranks for species in the remaining seven regions are as follows: ATR (2nd, 16 of 53 species; 30.2%); CGCR (3rd, 15 of 54 species; 27.8%); SLLR (4th, 13 of 39 species; 33.3%); VR (5th, 10 of 58 species; 17.2%); PIR (6th, 10 of 41 species; 24.4%); MR (7th, nine of 45 species; 20.0%); LCVR (8th, six of 59 species; 10.2%); CR (9th, five of 53 species; 9.4%); and BCCFR (10th, four of 27 species; 14.8%).

Based on the relative numbers of peninsular endemic and high vulnerability species, the 1st rank is held by the GIR, the Gulf Islands Region, in which there are 50 peninsular endemics and 45 high vulnerability species. The peninsular endemics include 33 lizards and 17 snakes. These species are indicated with a double asterisk (see Table 4). The GIR also supports 45 high vulnerability species, which are listed below (with the EVS score in parentheses):

*Crotaphytus insularis*** (16)
*Coleonyx gypsicolus*** (16)
*Ctenosaura hemilopha*** (16)
*Dipsosaurus catalinensis*** (17)
*Sauromalus hispidus*** (14)
*Sauromalus klauberi*** (17)
*Sauromalus slevini*** (16)
*Petrosaurus repens*** (14)
*Petrosaurus slevini*** (16)
*Petrosaurus thalassinus*** (17)
*Sceloporus angustus*** (16)
*Sceloporus grandaevus*** (17)
*Sceloporus hunsakeri*** (14)
*Sceloporus lineatulus*** (17)
*Uta encantadae*** (17)
*Uta lowei*** (17)
*Uta squamata*** (17)
*Uta tumidarostra*** (17)
*Phyllodactylus bugastrolepis*** (17)
*Phyllodactylus partidus*** (16)
*Phyllodactylus unctus*** (15)
*Aspidoscelis canus*** (17)
*Aspidoscelis carmenensis*** (17)
*Aspidoscelis catalinensis*** (17)
*Aspidoscelis celeripes*** (16)
*Aspidoscelis ceralbensis*** (17)
*Aspidoscelis danheimae*** (17)
*Aspidoscelis espiritensis*** (16)
*Aspidoscelis franciscensis*** (17)
*Aspidoscelis maximus*** (14)
*Aspidoscelis pictus*** (17)
*Lampropeltis catalinensis*** (18)
*Masticophis barbouri*** (17)
*Rhinocheilus etheridgei*** (17)
*Sonora punctatissima*** (15)
*Sonora savagei*** (16)
*Hypsiglena catalinae*** (16)
*Hypsiglena gularis*** (16)
*Hypsiglena marcosensis*** (16)
*Crotalus angelensis*** (18)
*Crotalus catalinensis*** (19)
*Crotalus lorenzoensis*** (19)
Crotalus mitchellii (15)
*Crotalus polisi*** (19)
*Crotalus thalassoporus*** (19)

All but one of these 45 species are peninsular endemics, and one is an MXUS species. As a group, their EVS values range from 14 to 19.

The 2nd rank, with respect to high vulnerability species, is held by the ATR, the Arid Tropical Region, which includes the following 16 high vulnerability species:

*Elgaria paucicarinata*** (14)
*Elgaria velazquezi*** (15)
*Bipes biporus*** (19)
*Ctenosaura hemilopha*** (16)
*Petrosaurus repens*** (14)
*Petrosaurus thalassinus*** (17)
*Sceloporus hunsakeri*** (14)
*Phyllodactylus unctus*** (15)
*Phyllodactylus xanti*** (15)
*Aspidoscelis maximus*** (14)
*Masticophis aurigulus*** (15)
*Sonora straminea*** (15)
*Rena boettgeri*** (14)
*Crotalus mitchellii*** (15)
*Trachemys nebulosa*** (15)
Gopherus morafkai (15)

All of these species are peninsular endemics except for one MXUS species. As a group, their EVS values range from 14 to 19.

The 3rd rank is held by the CGCR, the Central Gulf Coast Region, which includes the following 15 species:

*Elgaria paucicarinata*** (14)
*Elgaria velazquezi*** (15)
*Bipes biporus*** (19)
*Ctenosaura hemilopha*** (16)
*Petrosaurus repens*** (14)
*Petrosaurus thalassinus*** (17)
*Sceloporus hunsakeri*** (14)
*Phyllodactylus unctus*** (15)
*Phyllodactylus xanti*** (15)
*Aspidoscelis maximus*** (14)
*Masticophis aurigulus*** (15)

No. 21. *Sceloporus angustus* (Dickerson, 1919). The Isla Santa Cruz Spiny Lizard "is known only from Islas San Diego and Santa Cruz in the Gulf of California" (Grismer 2002: 158). This individual was found on Isla Santa Cruz, Gulf of California, in the municipality of Loreto. In this study its EVS is indicated as 16, placing it in the middle portion of the high vulnerability category. The IUCN judged its conservation status as Least Concern (LC), and SEMARNAT indicated it as Threatened (A). *Photo by Alan Harper.*

No. 22. *Sceloporus grandaevus* (female). The Isla Cerralvo Spiny Lizard "is endemic to Isla Cerralvo in the Gulf of California in the municipality of La Paz" (Grismer 2002: 159). In this study its EVS was calculated as 17, placing in the middle portion of the high vulnerability category. The IUCN determined its conservation status as Least Concern (LC), and SEMARNAT listed it as Threatened (A). *Photo by Jorge H. Valdez-Villavicencio.*

No. 23. *Sceloporus grandaevus* (male). This individual was from Isla Cerralvo, Baja California Sur. Please see the legend for No. 22 for information on its distribution and conservation status. *Photo by Tim Warfel.*

No. 24. *Sceloporus licki* Van Denburgh, 1895. The Cape Spiny Lizard "ranges along the mountainous foothill areas of the Cape Region from Rancho Ancón south to near La Soledad in the Sierra La Laguna…" (Grismer 2002: 173). This individual was found at Cañón San Dionisio, Sierra La Laguna, Baja California Sur, in the municipality of Los Cabos. Its EVS was determined as 13, placing it at the upper limit of the medium vulnerability category. The IUCN evaluated its conservation status as Least Concern (LC), and SEMARNAT determined it to be a species of Special Protection (Pr). *Photo by Jorge H. Valdez-Villavicencio.*

*Sonora straminea*** (15)
*Rena boettgeri*** (14)
*Crotalus mitchellii*** (15)
*Trachemys nebulosa*** (15)
Gopherus morafkai (15)

Of these 15 species, 14 (93.3%) are peninsular endemics, and one is a non-endemic. As a group, their EVS values range from 14 to 19.

The 4th rank is held by the SLLR, the Sierra La Laguna Region, which includes the following 13 high vulnerability species:

*Elgaria paucicarinata*** (14)
*Ctenosaura hemilopha*** (16)
*Petrosaurus thalassinus*** (17)
*Sceloporus hunsakeri*** (14)
*Phyllodactylus unctus*** (15)
*Phyllodactylus xanti*** (15)
*Aspidoscelis maximum*** (14)
*Xantusia gilberti*** (15)
*Masticophis aurigulus*** (15)
*Sonora straminea*** (15)
*Rena boettgeri*** (14)
*Crotalus mitchellii*** (15)
*Trachemys nebulosa*** (15)

All of these species are peninsular endemics. As a group, their EVS values range from 14 to 17.

The 5th rank is held by the VR, the Vizcaíno Region, which includes the following 10 high vulnerability species:

*Elgaria velazquezi*** (15)
*Anniella geronimensis*** (14)
*Bipes biporus*** (19)
*Petrosaurus repens*** (14)
*Phrynosoma cerroense*** (14)
*Urosaurus lahtelai*** (16)
*Aspidoscelis labialis*** (15)
*Arizona pacata*** (14)
*Crotalus mitchelli*** (15)
*Trachemys nebulosa*** (15)

Of these 10 species, all are are peninsular endemics (76.9%), and three are non-endemics. As a group, their EVS values range from 14 to 19.

The 6th rank is held by the PIR, the Pacific Islands Regions, which includes the following 10 high vulnerability species:

Aneides lugubris (14)
Batrachoseps major (14)
*Elgaria cedrosensis*** (16)
*Elgaria nana*** (16)
*Anniella geronimensis*** (14)
*Bipes biporus*** (19)
*Phrynosoma cerroense*** (14)
*Lampropeltis herrerae*** (20)
*Pituophis insulanus*** (17)
*Crotalus mitchellii*** (15)

Of the 10 species in the PIR, eight are peninsular endemics and two are non-endemics. As a group, their EVS values range from 14 to 20.

The 7th rank is held by the MR, the Magdalena Region, which includes the following nine high vulnerability species:

*Elgaria velazquezi*** (14)
*Bipes biporus*** (14)
*Ctenosaura hemilopha*** (18)
*Petrosaurus repens*** (14)
*Phrynosoma cerroense*** (16)
*Xantusia sherbrookei*** (16)
*Arizona pacata*** (14)
*Crotalus mitchellii*** (15)
*Trachemys nebulosa*** (18)

All nine of these species are peninsular endemics. As a group, their EVS values range from 14 to 18.

The 8th rank is held by the LCVR, the Lower California Valley Region, which includes the following six high vulnerability species:

*Crotaphytus grismeri*** (16)
Phrynosoma mcallii (15)
Uma notata (15)
Urosaurus graciosus (15)
Sonora annulata (14)
Crotalus cerastes (16)

Of these six species, five are non-endemics and one is a peninsular endemic. As a group, their EVS values range from 14 to 16.

The 9th rank is held by the CR, the California Region, which includes the following five high vulnerability species:

Aneides lugubris (14)
Batrachoseps major (14)
*Anniella geronimensis*** (14)
*Phrynosoma cerroense*** (14)
*Aspidoscelis labialis*** (15)

Three of these species are peninsular endemics, and the other two are non-endemics. As a group, their EVS values range from 14 to 15.

No. 25. *Sceloporus vandenburgianus* Cope, 1896. The Southern Sagebrush Lizard occurs "from the Coast Ranges in Los Angeles County, California, south to southern San Diego County. A disjunct population occurs in the Sierra Juarez and Sierra San Pedro Mártir, Baja California, Mexico…" (Grismer 2002: 174). This individual came from La Tasajera, Sierra San Pedro Mártir, in the municipality of Ensenada. In this study its EVS is noted as 14, placing it at the lower limit of the high vulnerability category. The IUCN judged its conservation status as Least Concern (LC), and SEMARNAT assessed it as a species of Special Protection (Pr). *Photo by Jorge H. Valdez-Villavicencio.*

No. 26. *Urosaurus nigricaudus* (Cope, 1864). The Black-tailed Brush Lizard "ranges along the eastern side of the Peninsular Ranges from San Diego County, California, south to the Cape Region of Baja California Sur" (Grismer 2002: 180). This individual was found in the Cañón San Dionisio, Sierra La Laguna, Baja California Sur, in the municipality of Los Cabos. In this study its EVS was estimated as 7, placing it in the upper portion of the low vulnerability category. The IUCN judged its conservation status at Least Concern (LC), and SEMARNAT listed it as Threatened (A). *Photo by Jorge H. Valdez-Villavicencio.*

No. 27. *Phyllodactylus unctus* (Cope, 1863). The San Lucan Leaf-toed Gecko "on the peninsula…is restricted to the Cape Region. In the Gulf of California, it has been reported from Islas Partida Sur, Espíritu Santo, Ballena, Gallo, Gallina, and Cerralvo…" Grismer 2002: 209). This individual was found in the Sierra Las Cacachilas, Baja California Sur, in the municipality of La Paz. In this study its EVS is indicated as 15, placing it in the lower portion of the high vulnerability category. The IUCN judged its conservation status as Near Threatened (NT), and SEMARNAT assessed this gecko as a species of Special Protection (Pr). *Photo by Jorge H. Valdez-Villavicencio.*

No. 28. *Plestiodon lagunensis* Van Denburgh, 1895. The San Lucan Skink "has a disjunct distribution throughout southern Baja California…In the Cape Region, it is restricted to the Sierra La Laguna and associated eastern foothills. North of the Cape Region, it is known from four localities: the vicinity of the Comondús; Santa Àgueda, approximately 150 km to the north…; northern Sierra Guadalupe; and San Francisco de la Sierra…" (Grismer 2002: 237–238). This individual came from La Purisima, Baja California Sur, in the municipality of Comondú. In this study its EVS was judged as 13, placing it at the upper limit of the medium vulnerability category. The IUCN assessed its conservation status as Least Concern (LC), and SEMARNAT indicated it as a species of Special Protection (Pr). *Photo by Jorge H. Valdez-Villavicencio.*

The 10th rank is held by the BCCFR, the Baja California Coniferous Forest Region, which includes the following four high vulnerability species:

Batrachoseps major (14)
Sceloporus vandenburgianus (14)
Lampropeltis multifasciata (14)
Thamnophis elegans (14)

All four of these species are non-endemics, and they all have EVS values of 14.

Natural Protected Areas in the Baja California Peninsula and its Adjacent Islands

Natural Protected Areas

In Mexico, natural protected areas (ANPs, from the Spanish acronym for "Areas Naturales Protegidas" or NPAs for "Natural Protected Areas" in English) are those established to preserve natural environments among the different landscapes of the country for the conservation of endemic and endangered species, as well as for maintaining their genetic diversity and for promoting sustainable use and scientific research.

The Baja California Peninsula contains 30 NPAs, which are divided into the following six categories: National Parks, Biosphere Reserves, Flora and Fauna Protection Areas, State Parks, State Reserves, and Voluntarily Designated Conservation Areas (Áreas Designadas Voluntariamente a la Conservación, or ADVC for the Spanish acronym). Of these, 17 are administrated at the federal level and two at the state level, while the remaining 11 are private (Table 20). Twenty-five of the NPAs are terrestrial and five are marine reserves. The NPAs were created between the years 1947 and 2022, with Sierra San Pedro Mártir National Park being the first reserve established in the Baja California Peninsula.

Terrestrial NPAs cover slightly more than 73,000 km^2, which corresponds to 49.5% of the total area of the Baja California Peninsula and its associated islands. The marine protected areas cover about 17,268 km^2 of marine habitat. Two NPAs are the largest in Mexico. The El Vizcaíno Biosphere Reserve in Baja California Sur is the largest in the country, followed by the Area de Protección de Flora y Fauna Valle de los Cirios in the state of Baja California, and each of these NPAs covers more than 20,000 km^2 of areal extension. Together they cover 56% of the total area designed for the protection of biodiversity and natural resources in the peninsula. In addition to the considerable protected land area represented by the NPAs, these areas are distributed in all 10 of the physiographic regions throughout the peninsula (Table 20), and thus represent all of its ecosystems.

Eleven natural protected areas are privately owned, primarily in such large areas as Valle de los Cirios and El Vizcaíno, which contain several towns and ranches. Although conservation objectives often are not compatible with the activities of the landowners (e.g., agriculture and cattle ranching), the federal governmental institutions promote agreements with them on the proper use of their resources, as well as in environmental education to properly carry out the management programs. Some of the Pacific Islands are inhabited, such as Cedros, Natividad, Guadalupe, Magdalena, and Santa Margarita, but the users do not own the land; and in most cases their use is primarily dedicated to fishing activities. For this reason, several NGOs collaborate with the staff of the NPAs to carry out adequate management programs and environmental education for the proper management of the resources, and also to avoid the introduction of non-native species into the islands. In areas such as the Sierra San Pedro Mártir, however, relationships with the landowners are complicated, as they use the core areas of the NPAs for cattle ranching.

Regarding herpetofaunal inventories, only six of the 23 terrestrial areas (26.1%) have conducted them. This situation highlights the general lack of sufficient herpetological surveys in these areas. In all seven of the marine reserves, five species of turtles are known to inhabit these areas (*Chelonia mydas*, *Caretta caretta*, *Lepidochelys olivacea*, *Eretmochelys imbricata*, and *Dermochelys coriacea*), in addition to the Yellow-bellied Sea Snake (*Hydrophis platurus*). Only one of these marine areas, Complejo Lagunar Ojo de Liebre, is located in the Pacific Ocean, and the remainder are in the Gulf of California.

Effectiveness of the Natural Protected Areas in the Baja California Peninsula and Its Adjacent Islands

The available information on the distribution of the herpetofaunal species known to occur within the NPAs in the Baja California Peninsula and its adjacent islands are shown in Table 21, and the results are summarized in Table 22. The data in these tables indicate that 157 (91.3%) of the 172 total species known from this region of Mexico have been recorded in one to 25 of the 30 NPAs. Thus, 15 species recorded from the Baja California Peninsula and its adjacent islands have not been recorded from any of the NPAs, and therefore are not included in Table 21. These 15 species are: *Anaxyrus woodhousii*, *Incilius alvarius*, *Smilisca baudinii****, *Xenopus laevis****, *Lithobates berlandieri****, *L. forreri****, *L. yavapaiensis*, *Crotaphytus grismeri***, *Gehyra mutilata****, *Uma notata, Xantusia sherbrookei***, *Thamnophis marcianus*, *Kinosternon integrum****, *Gopherus morafkai*, and *Apalone spinifera****. Seven of these 15 species (indicated by triple asterisks) are non-native to the Baja California Peninsula and its adjacent islands, and thus are not desirable for inclusion in any of the NPAs. Therefore, only eight species (the two country endemics indicated by double asterisks and the six non-endemics) should

No. 29. *Aspidoscelis catalinensis*. The Isla Santa Catalina Whiptail "is endemic to Isla Santa Catalina, in the Gulf of California, Baja California Sur" (Grismer 2002: 230). In this study its EVS was estimated as 17, placing it in the middle portion of the high vulnerability category. The IUCN judged its conservation status as Vulnerable (VU), and SEMARNAT assessed it as a species of Special Protection (Pr). *Photo by Tim Warfel.*

No. 30. *Aspidoscelis hyperythrus* (Cope, 1863). The Orange-throated Whiptail occurs "from Orange and San Bernardino counties of southern California south to Cabo San Lucas…" (Grismer 2002: 212). This individual came from Rancho Meling, Sierra San Pedro Mártir, Baja California, in the municipality of San Quintín. In this study its EVS was determined as 10, placing it at the lower limit of the medium vulnerability category. The IUCN evaluated its conservation status as Least Concern (LC), and SEMARNAT judged it as Threatened (A). *Photo by Jorge H. Valdez-Villavicencio.*

No. 31. *Aspidoscelis labialis* (Stejneger, 1890). The Baja California Whiptail "ranges along a narrow strip of the Pacific coast, from Punta San José just south of Ensenada south to at least 6 km southeast of Guerrero Negro. It generally extends no more than 16 km inland…in the northern Vizcaíno Desert and even less so farther north" (Grismer 2002: 220). This individual was found at Guerrero Negro, Baja California Sur, in the municipality of Mulegé. In this study its EVS was estimated as 15, placing it in the lower portion of the high vulnerability category. The IUCN judged its conservation status as Vulnerable (VU), and SEMARNAT listed it as a species of Special Protection (Pr). *Photo by Jorge H. Valdez-Villavicencio.*

No. 32. *Aspidoscelis maximus* (Cope, 1863). The Cape Region Whiptail is distributed in the Cape Region from Bahía La Paz to Cabo San Lucas, including the Gulf islands of Partida Sur and Espíritu Santo (Grismer 2002). This individual was located at Sierra Las Cacachilas, in the municipality of La Paz. In this study its EVS was calculated as 14, placing it at the lower limit of the high vulnerability category. The IUCN has not assessed the conservation status of this species, but it was evaluated by SEMARNAT as a species of Special Protection (Pr). *Photo by Alan Harper.*

Table 20. Characteristics of the Natural Protected Areas in the Baja California Peninsula, Mexico. Abbreviations in the Facilities available column are as follows: A = administrative services; R = park guards; S = system of pathways; and V = facilities for visitors.

Name	Category	Date of decree	Area (ha)	Municipalities	Jurisdiction	Physiographic regions	Facilities available	Occupied by landowners	Herpetofaunal survey completed	Management plan available
Constitución de 1857	Parque Nacional	27 Apr 1962	5,009.5	Ensenada	Federal	Baja California Coniferous Forest	A, R, S, V	Yes	No	Yes
Alto Golfo de California y Delta del Río Colorado	Reserva de la Biósfera	10 Jun 1993	1,340	Mexicali, San Felipe	Federal	Lower Colorado Valley	A, R, S	Yes	No	Yes
Arroyo San Miguel	Parque Estatal	17 Sep 2021	67	Ensenada	State	California	None	Yes	No	No
Sierra San Pedro Mártir	Parque Nacional	26 Apr 1947	72,910.7	Ensenada	Federal	Baja California Coniferous Forest	A, R, S, V	Yes	Yes	Yes
Los Montes de San Pedro I, II, III	ADVC	31 May 2019	4,502	Ensenada	Private	Baja California Coniferous Forest	A	Yes	No	Yes
Reserva Natural San Quintín	ADVC	22 Jan 2021	201	San Quintín	State	California	A	No	No	Yes
Reserva Natural Punta Mazo	ADVC	20 Oct 2014	832.5	San Quintín	Private	California	R, S, V	No	Yes[A]	Yes
Reserva Natural Monte Ceniza	ADVC	18 Apr 2017	803.4	San Quintín	Private	California	R, S	No	No	Yes
Reserva Natural Valle Tranquillo	ADVC	24 Oct 2013	3,691.2	San Quintín	Private	California, Vizcaíno	R, S	No	No	Yes
Valle de los Cirios	Área de Protección de Flora y Fauna	2 Jun 1980	2,521,987.6	San Quintín, San Felipe	Federal	Vizcaíno	A, R, S	Yes	No	Yes
Costa Salvaje Wildlands I, II, III, IV	ADVC	2013, 2014, 2016, 2019	17,532.8	San Quintíín	Private	Vizcaíno	A	No	No	No
Islas del Golfo de California	Área de Protección de Flora y Fauna	2 Aug 1978	374,553.6	Mexicali, San Felipe, San Quintín, Mulegé, Loreto, La Paz	Federal	Gulf Islands	A	No**	Yes	Yes
Isla Guadalupe	Reserva de la Biósfera	25 Apr 2005	476,971.2	Ensenada	Federal	Pacific Islands	A, S, V	Yes***	Yes*	Yes
Islas del Pacífico de la Peninsula de Baja California	Reserva de la Biósfera	7 Dec 2016	1,161,223	Tijuana, Ensenado, San Quintín, Mulegé, Comondú	Federal	Pacific Islands	A	No****	Yes	No
Zona Marina del Archipiélago de San Lorenzo	Parque National	25 Apr 2005	58,442.8	San Quintín	Federal	Gulf Islands	A	No	No	Yes

Table 20 (continued). Characteristics of the Natural Protected Areas in the Baja California Peninsula, Mexico. Abbreviations in the Facilities available facilities column are as follows: A = administrative services; R = park guards; S = system of pathways; and V = facilities for visitors.

Name	Category	Date of decree	Area (ha)	Municipalities	Jurisdiction	Physiographic regions	Facilities available	Occupied by landowners	Herpetofaunal survey completed	Management plan available
Zona Marina Bahía de los Ángeles, Canales de Ballenas y Salsipuedes	Reserva de la Biósfera	5 Jun 2007	387,956.9	San Quintín	Federal	Gulf Islands	A	No	No	Yes
Complejo Lagunar Ojo de Liebre	Reserva de la Biósfera	28 Mar 1980	79,329	San Quintín, Mulegé	Federal	Vizcaíno	A, R, S	No	No	Yes
El Vizcaíno	Reserva de la Biósfera	30 Nov 1988	2,546,790.2	Mulegé	Federal	Vizcaíno	A, R, S	Yes	Yes	Yes
Servidumbre Ecológica Rancho San Cistóbal-Majiben	ADCV	3 May 2012	538.5	Mulegé	Private	Vizcaíno	A, S	Yes	No	No
Bahía de Loreto	Parque National	19 Jul 1996	206,580.7	Loreto	Federal	Gulf Islands	A	No	No	Yes
Reserva Ecológica Llanos de Magdalena I, II	ADCV	2013, 2014	1,067	Comondú	Private	Magdalena	A, S	No	No	No
Reserva Natural el Portezuelo I, II, III, IV, V	ADCV	2013, 2014, 2019	6,825.1	Loreto, La Paz	Private	Central Gulf Coast	A, S	No	No	No
Santa Martha	ADCV	1 Jun 2016	479	Loreto	Private	Central Gulf Coast	A, S	No	No	No
Zona Marina del Archipiélago de Espíritu Sano	Parque National	10 May 2007	48,654.8	La Paz	Federa;	Central Gulf Coast	A, R	No	No	Yes
Balandra	Área de Protección de Flora y Fauna	30 Nov 2012	2,512.7	La Paz	Federal	Central Gulf Coast	A, S	No	No	Yes
Non-such	ADCV	28 Jul 2022	80	La Paz	Private	Magdalena	A, S	No	No	No
Sierra La Laguna	Reserva de la Biósfera	6 Jun 1994	112,437	La Paz, Los Cabos	Federal	Sierra Laguna	A, R, S	Yes	Yes	Yes
Cabo Pulmo	Parque Nacional	6 Jun 1995	7,111	Los Cabos	Federal	Central Gulf Coast	A, R, V	No	No	Yes
Estero de San José del Cabo	Parque Nacional	10 Jan 1994	512.2	Los Cabos	State	Arid Tropical	A	No	No	Yes
Cabo San Lucas	Área de Protección de Flora y Fauna	29 Nov 1973	3,996	Los Cabos	Federal	Arid Tropical	A	Yes	No	Yes

No. 33. *Xantusia henshawi* Stejneger, 1893. The Granite Night Lizard "ranges from western Riverside County, California, south into northwestern Baja California, to at least Cañón el Cajón of the Sierra San Pedro Mártir in the east and Valle la Trinidad in the west…" (Grismer 2002: 233). This individual was found at Rancho Meling, Sierra San Pedro Mártir, in the municipality of San Quintín. Its EVS was indicated as 11, placing it in the lower portion of the medium vulnerability category. The IUCN determined its conservation status as Least Concern (LC), but this species is not listed by SEMARNAT. *Photo by Jorge H. Valdez-Villavicencio.*

No. 34. *Xantusia wigginsi* Savage, 1952. Wiggins' Night Lizard ranges from southern San Diego County, California southward to northeastern Baja California Sur (http://californiaherps.com; accessed 11 December 2022). This individual came from south of Cataviña, Baja California, in the municipality of San Quintín. The species EVS was determined as 11, placing it at the lower portion of the medium vulnerability category. This species is not listed by either the IUCN or SEMARNAT. *Photo by Jorge H. Valdez-Villavicencio.*

No. 35. *Lichanura trivirgata* Cope, 1861. The Rosy Boa "ranges widely throughout the Mojave and Sonoran deserts of the southwestern United States and northern Mexico, as well as coastal regions of southern California…In Baja California, *L. trivirgata* occurs in all areas…except for the upper elevations of the northern Peninsular Ranges…and the Sierra La Laguna" (Grismer 2002: 260). This individual was found on Isla Cedros, in the municipality of Ensenada. In this study its EVS was estimated as 10, placing it at the lower limit of the medium vulnerability category. The IUCN judged its conservation status as Least Concern (LC), and SEMARNAT calculated it as Threatened (A). *Photo by Jorge H. Valdez-Villavicencio.*

No. 36. *Arizona pacata* Klauber, 1946. The Peninsular Glossy Snake "ranges along the Pacific coast of the southern two-thirds of Baja California from at least the turnoff to Bahía de los Ángeles south to 20 km north of La Paz" (Grismer 2002: 265). This individual was found in Guerrero Negro, Baja California Sur, in the municipality of Mulegé. In this study its EVS was determined as 14, placing it at the lower limit of the high vulnerability category. The IUCN assessed its conservation status as Least Concern (LC), but this snake is not listed by SEMARNAT. *Photo by Tim Warfel.*

No. 37. *Bogertophis rosaliae* (Mocquard, 1899). The Baja California Rat Snake occurs "throughout the rocky slopes of the Peninsular Ranges from Mountain Springs, San Diego County, California, south to Cabo San Lucas…" (Grismer 2002: 266). This individual came from the Sierra Las Cacachilas, Baja California Sur, in the municipality of La Paz. In this study its EVS was estimated as 11, placing it in the medium vulnerabilty category. The IUCN assessed its conservation status as Least Concern (LC), but this species is not listed by SEMARNAT. *Photo by Jorge H. Valdez-Villavicencio.*

No. 38. *Masticophis aurigulus* (Cope, 1861). The Cape Striped Racer "is known only from the Cape Region of Baja California, along the eastern slopes of the Sierra La Laguna…" (Grismer 2002: 286). This individual came from San Bartolo, Baja California Sur, in the municipality of La Paz. In this study its EVS was calculated as 15, placing it in the lower portion of the high vulnerability category. The IUCN assessed its conservation status as Least Concern (LC), and SEMARNAT determined its conservation status as Threatened (A). *Photo by Jorge H. Valdez-Villavicencio.*

No. 39. *Masticophis fuliginosus* (Cope, 1895). The Baja California Coachwhip "ranges from extreme southwestern California south to Cabo San Lucas" (Grismer 2002: 290). This individual was encountered in the Sierra Las Cacachilas, Baja California Sur, in the municipality of La Paz. In this study its EVS was estimated as 9, placing it at the upper limit of the low vulnerability category. This species is not listed by either the IUCN or SEMARNAT. *Photo by Jorge H. Valdez-Villavicencio.*

No. 40. *Pituophis vertebralis* (Blainville, 1835). The Baja California Gopher Snake "is endemic to Baja California peninsula, ranging continuously throughout cismontane areas from at least 43 km south (by road) of El Rosario south to Cabo San Lucas…" (Grismer 2002: 298). This individual was found in the Sierra Las Cacachilas, Baja California Sur, in the municipality of La Paz. In this study its EVS was determined as 13, placing it at the upper limit of the medium vulnerability category. The IUCN assessed its conservation status as Least Concern (LC), but this snake is not listed by SEMARNAT. *Photo by Jorge H. Valdez-Villavicencio.*

Table 21. Distribution of herpetofaunal species in the Natural Protected Areas of the Baja California Peninsula, Mexico. Abbreviations are as follows: * = species endemic to Mexico; ** = species endemic to Baja California; and *** = non-native species. The numbers of the Natural Protected Areas signify the following: 1 = Constitución de 1857; 2 = Alto Golfo y Delta del Río Colorado; 3 = Arroyo San Miguel; 4 = Sierra San Pedro Mártir; 5 = Los Montes de San Pedro; 6 = Reserva Natural San Quintín; 7 = Reserva Natural Punta Mazo; 8 = Reserva Natural Monte Ceniza; 9 = Reserva Natural Valle Tranquilo; 10 = Valle de los Cirios; 11 = Costa Salvaje Wildlands; 12 = Islas del Golfo de California; 13 = Isla Guadalupe; 14 = Islas del Pacífico de la Península de Baja California; 15 = Zona Marina del Archipielago de San Lorenzo; 16 = Zona Marina Bahía de los Ángeles, Canales de Ballenas y Salsipuedes; 17 = Complejo Lagunar Ojo de Liebre; 18 = El Vizcaíno; 19 = Servidumbre Ecológica Rancho San Cristóbal-Majiben; 20 = Bahía de Loreto; 21 = Reserva Ecológica Llanos de Magdalena; 22 = Reserva Natural El Portezuelo; 23 = Santa Martha; 24 = Zona marina del Archipiélago de Espíritu Santo; 25 = Balandra; 26 = Non-Such; 27 = Sierra La Laguna; 28 = Cabo Pulmo; 29 = Estero de San José del Cabo; and 30 = Cabo San Lucas.

Taxon	Natural Protected Areas																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
AMPHIBIA (14 species)																														
Anura (11 species)																														
Bufonidae (4 species)																														
Anaxyrus boreas	+		+	+	+				+	+																				
Anaxyrus californicus	+			+	+																									
Anaxyrus cognatus		+																												
Anaxyrus punctatus										+	+	+						+	+	+	+	+	+		+	+	+		+	
Hylidae (2 species)																														
Pseudacris cadaverina	+		+	+	+					+																				
Pseudacris hypochondriaca	+		+	+	+				+	+				+				+							+		+		+	
Ranidae (3 species)																														
*Lithobates catesbeianus****																		+												
Rana draytonii				+																										
Rana boylii				+																										
Scaphiopodidae (2 species)																														
Scaphiopus couchii		+								+		+						+				+	+		+	+	+			
Spea hammondii	+		+						+																					
Caudata (3 species)																														
Plethodontidae (3 species)																														
Aneides lugubris			+											+																
Batrachoseps major	+		+	+	+									+																
Ensatina eschscholtzii	+			+																										
REPTILIA (143 species)																														
Squamata (135 species)																														
Anguidae (5 species)																														
*Elgaria cedrosensis***										+	+			+																
Elgaria multicarinata	+		+	+	+				+	+				+																
*Elgaria nana***														+																
*Elgaria paucicarinata***																											+		+	
*Elgaria velazquezi**																		+				+								
Anniellidae (2 species)																														
*Anniella geronimensis***							+							+																
Anniella stebbinsi														+																
Bipedidae (1 species)																														
*Bipes biporus***										+				+				+	+		+					+				
Crotaphytidae (4 species)																														
*Crotaphytus insularis***												+																		
Crotaphytus vestigium										+								+												
*Gambelia copeii***									+	+	+			+				+	+		+					+				
Gambelia wislizenii		+																												
Eublepharidae (3 species)																														
*Coleonyx gypsicolus***												+																		
Coleonyx switaki		+								+								+												
Coleonyx variegatus	+	+	+		+	+	+	+	+	+	+	+		+				+	+		+	+	+		+	+	+		+	+
Gekkonidae (2 species)																														

No. 41. *Salvadora hexalepis* (Cope, 1866). The Western Patch-nosed Snake is distributed "through much of the American southwest and most of northwestern Mexico. In Baja California, *S. hexalepis* ranges throughout the entire peninsula…except for the upper elevations of the Sierra Juárez and Sierra San Pedro Mártir…It is known from the Pacific islands of San Gerónimo and Todos Santos and from the Gulf islands of Espíritu Santo, San José, and Tiburón" (Grismer 2002: 303). This individual was found in the Sierra Las Cacachilas, Baja California Sur, in the municipality of La Paz. Its EVS was calculated as 9, placing it at the higher limit of the low vulnerability category. The IUCN assessed its conservation status as Least Concern (LC), but this species is not listed by SEMARNAT. *Photo by Jorge H. Valdez-Villavicencio.*

No. 42. *Sonora annulata* (Baird, 1859). The Shovel-nosed Snake is distributed "in the Colorado and Sonoran Deserts of Arizona and California in the USA, and in the states of Baja California and Sonora in Mexico" (Cox et al. 2018). "In Baja California, *S. annulata* is restricted to the Lower Colorado Valley Region, extending 34 km south of San Felipe" (Grismer 2002: 271). This individual was located at Restaurant El Michoacán, El Chinero, Baja California in the municipality of Mexicali. The species EVS was calculated as 14, placing it at the lower limit of the high vulnerability category. This snake is not listed by either IUCN or SEMARNAT. *Photo by Tim Warfel.*

No. 43. *Sonora fasciata* (Cope, 1892). The Banded Sand Snake is distributed "from the central Baja California Peninsula at least as far north as Las Tres Virgenes to southern Baja California Sur near El Triunfo" (Cox et al. 2018). This individual came from near Loreto, Baja California Sur, in the municipality of Loreto. In this study its EVS was assessed as 12, placing it in the higher portion of the middle vulnerability category. This species is not listed by the IUCN, but SEMARNAT lists it as a species of Special Protection (Pr). *Photo by Jorge H. Valdez-Villavicencio.*

No. 44. *Hypsiglena slevini* Tanner, 1943. The Slevin's Night Snake occurs from near Puertecitos in the north (Murray et al. 2015) and "ranges continuously from at least Bahía de los Ángeles in the north to Cabo San Lucas in the south…It is also known from Isla Santa Margarita, of the west coast of Baja California…and from Islas Cerralvo and Danzante in the Gulf of California" (Grismer 2002: 273). This individual came from Sierra la Gata, Baja California Sur, in the municipality of La Paz. In this study its EVS is noted as 11, placing it in the lower portion of the medium vulnerability category. The IUCN assessed its conservation status as Least Concern (LC), but SEMARNAT judged its conservation status as Threatened (A). *Photo by Jorge H. Valdez-Villavicencio.*

Table 21 (continued). Distribution of herpetofaunal species in the Natural Protected Areas of the Baja California Peninsula, Mexico. Abbreviations are as follows: * = species endemic to Mexico; ** = species endemic to Baja California; and *** = non-native species. The numbers of the Natural Protected Areas signify the following: 1 = Constitución de 1857; 2 = Alto Golfo y Delta del Río Colorado; 3 = Arroyo San Miguel; 4 = Sierra San Pedro Mártir; 5 = Los Montes de San Pedro; 6 = Reserva Natural San Quintín; 7 = Reserva Natural Punta Mazo; 8 = Reserva Natural Monte Ceniza; 9 = Reserva Natural Valle Tranquilo; 10 = Valle de los Cirios; 11 = Costa Salvaje Wildlands; 12 = Islas del Golfo de California; 13 = Isla Guadalupe; 14 = Islas del Pacífico de la Península de Baja California; 15 = Zona Marina del Archipielago de San Lorenzo; 16 = Zona Marina Bahía de los Ángeles, Canales de Ballenas y Salsipuedes; 17 = Complejo Lagunar Ojo de Liebre; 18 = El Vizcaíno; 19 = Servidumbre Ecológica Rancho San Cristóbal-Majiben; 20 = Bahía de Loreto; 21 = Reserva Ecológica Llanos de Magdalena; 22 = Reserva Natural El Portezuelo; 23 = Santa Martha; 24 = Zona marina del Archipiélago de Espíritu Santo; 25 = Balandra; 26 = Non-Such; 27 = Sierra La Laguna; 28 = Cabo Pulmo; 29 = Estero de San José del Cabo; and 30 = Cabo San Lucas.

Taxon	Natural Protected Areas																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
*Hemidactylus frenatus****												+						+									+	+	+	+
*Hemidactylus turcicus****		+																												
Iguanidae (9 species)																														
*Ctenosaura hemilopha***												+													+	+	+		+	+
*Dipsosaurus catalinensis***												+																		
Dipsosaurus dorsalis		+								+	+	+		+				+	+		+	+	+		+	+	+		+	+
*Iguana rhinolopha****																													+	
Sauromalus ater										+		+						+				+	+		+					
*Sauromalus hispidus***												+																		
*Sauromalus klauberi***												+																		
*Sauromalus slevini***												+																		
*Sauromalus varius****												+																		
Phrynosomatidae (29 species)																														
Callisaurus draconoides		+								+	+	+						+	+	+	+	+	+		+	+	+		+	+
Petrosaurus mearnsi										+		+																		
*Petrosaurus repens***										+		+						+				+	+							
*Petrosaurus slevini***												+																		
*Petrosaurus thalassinus***												+															+			+
Phrynosoma blainvillii	+		+																											
*Phrynosoma cerroense***						+	+	+	+	+	+			+				+	+											
*Phrynosoma coronatum***																					+	+	+		+	+	+		+	+
Phrynosoma mcallii		+																												
Phrynosoma platyrhinos		+																												
*Sceloporus angustus***												+																		
*Sceloporus grandaevus***												+																		
*Sceloporus hunsakeri***												+													+		+		+	+
*Sceloporus licki***																											+			
*Sceloporus lineatulus***												+																		
Sceloporus magister		+																												
Sceloporus occidentalis	+		+	+	+				+					+																
Sceloporus orcutti	+			+	+					+	+	+						+				+	+							
Sceloporus vandenburgianus	+			+																										
*Sceloporus zosteromus***						+	+	+	+	+	+	+		+				+	+		+	+	+		+	+	+		+	+
Urosaurus graciosus		+								+																				
*Urosaurus lahtelai***										+																				
Urosaurus nigricaudus										+	+	+		+				+	+		+	+	+		+	+	+		+	+
Urosaurus ornatus		+																												
*Uta encantadae***												+																		
*Uta lowei***												+																		
*Uta squamata***												+																		
Uta stansburiana	+	+	+	+	+	+	+	+	+	+	+	+		+				+	+	+	+	+	+		+	+	+	+	+	+
*Uta tumidarostra***												+																		
Phyllodactylidae (5 species)																														
*Phyllodactylus bugastrolepis***												+																		
Phyllodactylus nocticolus										+	+	+		+				+			+	+	+							

No. 45. *Rena boettgeri* (Werner, 1899). The Cape Threadsnake is distributed at "low elevations (up to 300 m) in the Cape region of the Baja California Peninsula (Isthmus of La Paz to Cabo San Lucas) and on Isla Cerralvo" (Heimes 2016: 27). This individual came from La Paz, Baja California Sur, in the municipality of La Paz. In this study its EVS was estimated as 14, placing it at the lower limit of the high vulnerability category. This species is not listed by either the IUCN or SEMARNAT. *Photo by Jorge H. Valdez-Villavicencio.*

No. 46. *Rena humilis* (Baird and Girard, 1853). The Western Threadsnake "ranges throughout the southwestern United States and western Mexico" (Heimes 2016: 30). This individual was found in Ensenada, Baja California, in the municipality of Ensenada. In this study its EVS was determined as 8, placing it in the upper portion of the low vulnerability category. The IUCN judged its conservation status as Least Concern (LC), but this threadsnake is not listed by SEMARNAT. *Photo by Jorge H. Valdez-Villavicencio.*

No. 47. *Thamnophis elegans* (Baird and Girard, 1853). The Western Terrestrial Garter Snake "ranges continuously from southwestern Canada, south through the western United States to central Nevada, Arizona, and New Mexico, nearly to the edges of the Mojave and Sonoran deserts. It is known from isolated populations in the Sierra Nevada and the San Bernardino Mountains of California as well as central New Mexico…In Baja California, *T. elegans* occurs in another isolated population from the Sierra San Pedro Mártir" (Grismer 2002: 308). This individual came from La Grulla, Sierra San Pedro Mártir, in the municipality of Ensenada. In this study its EVS was calculated as 14, placing it at the lower limit of the high vulnerability category. The IUCN judged its conservation status as Least Concern (LC), but SEMARNAT assessed it as Threatened (A). *Photo by Jorge H. Valdez-Villavicencio.*

No. 48. *Thamnophis validus* (Kennicott, 1860). The West Coast Garter Snake "has a fragmented distribution along the west coast of southwestern Mexico from southern Sonora south to Guerrero…In Baja California, it also has a fragmented distribution and is known from water systems near La Burrera along the western face of the Sierra La Laguna and the watercourses and systems associated with Santiago, Agua Caliente, and Miraflores along the eastern face of the Sierra La Laguna" (Grismer 2002: 312). This individual is from Miraflores, Baja California Sur, in the municipality of Los Cabos. In this study its EVS was determined as 11, placing it in the lower portion of the medium vulnerability category. The IUCN assessed its conservation status as Least Concern (LC), but this species is not listed by SEMARNAT. *Photo by Tim Warfel.*

Table 21 (continued). Distribution of herpetofaunal species in the Natural Protected Areas of the Baja California Peninsula, Mexico. Abbreviations are as follows: * = species endemic to Mexico; ** = species endemic to Baja California; and *** = non-native species. The numbers of the Natural Protected Areas signify the following: 1 = Constitución de 1857; 2 = Alto Golfo y Delta del Río Colorado; 3 = Arroyo San Miguel; 4 = Sierra San Pedro Mártir; 5 = Los Montes de San Pedro; 6 = Reserva Natural San Quintín; 7 = Reserva Natural Punta Mazo; 8 = Reserva Natural Monte Ceniza; 9 = Reserva Natural Valle Tranquilo; 10 = Valle de los Cirios; 11 = Costa Salvaje Wildlands; 12 = Islas del Golfo de California; 13 = Isla Guadalupe; 14 = Islas del Pacífico de la Península de Baja California; 15 = Zona Marina del Archipielago de San Lorenzo; 16 = Zona Marina Bahía de los Ángeles, Canales de Ballenas y Salsipuedes; 17 = Complejo Lagunar Ojo de Liebre; 18 = El Vizcaíno; 19 = Servidumbre Ecológica Rancho San Cristóbal-Majiben; 20 = Bahía de Loreto; 21 = Reserva Ecológica Llanos de Magdalena; 22 = Reserva Natural El Portezuelo; 23 = Santa Martha; 24 = Zona marina del Archipiélago de Espíritu Santo; 25 = Balandra; 26 = Non-Such; 27 = Sierra La Laguna; 28 = Cabo Pulmo; 29 = Estero de San José del Cabo; and 30 = Cabo San Lucas.

Taxon	Natural Protected Areas																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
*Phyllodactylus partidus***												+																		
*Phyllodactylus unctus***												+															+		+	+
*Phyllodactylus xanti***																									+	+	+		+	+
Scincidae (3 species)																														
Plestiodon gilberti	+			+	+																									
*Plestiodon lagunensis***																			+								+			
Plestiodon skiltonianus	+			+	+	+	+	+	+					+																
Teiidae (13 species)																														
*Aspidoscelis canus***												+																		
*Aspidoscelis carmenensis***												+																		
*Aspidoscelis catalinensis***												+																		
*Aspidoscelis celeripes***												+																		
*Aspidoscelis ceralbensis***												+																		
*Aspidoscelis danheimae***												+																		
*Aspidoscelis espiritensis***												+																		
*Aspidoscelis franciscensis***												+																		
Aspidoscelis hyperythrus			+			+	+	+	+	+	+	+		+				+	+		+	+	+		+	+	+		+	+
*Aspidoscelis labialis***						+	+	+	+	+	+							+												
*Aspidoscelis maximus***												+													+		+		+	+
*Aspidoscelis pictus***												+																		
Aspidoscelis tigris	+		+			+	+	+	+	+	+	+		+				+	+		+	+	+							
Xantusiidae (3 species)																														
*Xantusia gilberti***																											+			
Xantusia henshawi	+																													
Xantusia wigginsi									+	+	+							+												
Charinidae (1 species)																														
Lichanura trivirgata	+		+		+				+	+	+	+		+				+			+	+	+		+	+	+		+	+
Colubridae (29 species)																														
Arizona elegans		+	+			+	+	+	+	+	+																			
*Arizona pacata***										+								+	+		+									
Bogertophis rosaliae										+		+						+							+		+			
Lampropeltis californiae	+	+	+		+	+	+	+	+	+	+	+						+	+		+	+	+		+	+	+		+	+
*Lampropeltis catalinensis***												+																		
*Lampropeltis herrerae***														+																
Lampropeltis multifasciata	+			+	+																									
*Masticophis aurigulus***																											+			
*Masticophis barbouri***												+																		
Masticophis flagellum		+																												
Masticophis fuliginosus			+		+	+	+	+	+	+	+	+		+				+	+		+	+	+		+	+	+		+	+
Masticophis lateralis			+		+	+	+	+	+	+								+												
Phyllorhynchus decurtatus		+								+		+						+				+	+		+	+				
Pituophis catenifer	+	+	+		+	+	+	+	+	+	+			+																
*Pituophis insulanus***														+																
*Pituophis vertebralis***										+	+	+		+				+	+		+	+	+		+	+	+		+	+
*Rhinocheilus etheridgei***												+																		

No. 49. *Crotalus angelensis* Klauber, 1963. The Isla Ángel de la Guarda Rattlesnake "is endemic to Isla Ángel de la Guarda in the Gulf of California" (Grismer 2002: 333), from where this individual originated. In this study its EVS was assessed as 18, placing in the upper portion of the high vulnerability category. The IUCN judged its conservation status as Least Concern (LC), but this rattlesnake is not listed by SEMARNAT. *Photo by Tim Warfel.*

No. 50. *Crotalus enyo* (Cope, 1861). The Baja California Rattlesnake "ranges throughout most of Baja California. In the north, its contact with the Pacific coast occurs in the vicinity of Cabo Colonet and with the Gulf coast near Bahía de los Angeles. From here, *C. enyo* continues south throughout all of Baja California…It is also known from the Pacific islands of Magdalena and Santa Margarita and the Gulf islands of Carmen, Cerralvo, Coronados, Espíritu Santo, Pardo, Partida Sur, San Francisco, San José, and San Marcos…" (Grismer 2002: 328–329). This individual was found at Guerrero Negro, Baja California Sur, in the municipality of Mulegé. In this study its EVS was estimated as 13, placing it at the upper limit of the medium vulnerability category. The IUCN assessed its conservation status as Least Concern (LC), but SEMARNAT judged its status as Threatened (A). *Photo by Jorge H. Valdez-Villavicencio.*

No. 51. *Crotalus polisi* Meik, Schaack, Flores-Villelam and Streicher, 2018. The Isla Cabeza de Caballo Speckled Rattlesnake or Horsehead Island Speckled Rattlesnake is endemic to Isla Cabeza de Caballo Island in the Gulf of California, municipality of San Quintín. The species EVS was calculated as 19. The species is not listed by the IUCN, but SEMARNAT assessed its conservation status as Special Protection (Pr). *Photo by Tim Warfel.*

No. 52. *Crotalus pyrrhus* (Cope, 1866). The Southwestern Speckled Rattlesnake is distributed from southeastern Nevada, western Arizona, and southern California southward into the northern half of the Baja California Peninsula (Meik et al. 2015). This individual is from Rancho La Costilla, Sierra San Pedro Mártir, in the municipality of San Quintín. Its EVS was assessed as 13, placing it at the upper limit of the medium vulnerability category. This species is not listed by the IUCN, but it is listed by SEMARNAT as a species of Special Protection (Pr). *Photo by Ivan Parr.*

Table 21 (continued). Distribution of herpetofaunal species in the Natural Protected Areas of the Baja California Peninsula, Mexico. Abbreviations are as follows: * = species endemic to Mexico; ** = species endemic to Baja California; and *** = non-native species. The numbers of the Natural Protected Areas signify the following: 1 = Constitución de 1857; 2 = Alto Golfo y Delta del Río Colorado; 3 = Arroyo San Miguel; 4 = Sierra San Pedro Mártir; 5 = Los Montes de San Pedro; 6 = Reserva Natural San Quintín; 7 = Reserva Natural Punta Mazo; 8 = Reserva Natural Monte Ceniza; 9 = Reserva Natural Valle Tranquilo; 10 = Valle de los Cirios; 11 = Costa Salvaje Wildlands; 12 = Islas del Golfo de California; 13 = Isla Guadalupe; 14 = Islas del Pacífico de la Península de Baja California; 15 = Zona Marina del Archipielago de San Lorenzo; 16 = Zona Marina Bahía de los Ángeles, Canales de Ballenas y Salsipuedes; 17 = Complejo Lagunar Ojo de Liebre; 18 = El Vizcaíno; 19 = Servidumbre Ecológica Rancho San Cristóbal-Majiben; 20 = Bahía de Loreto; 21 = Reserva Ecológica Llanos de Magdalena; 22 = Reserva Natural El Portezuelo; 23 = Santa Martha; 24 = Zona marina del Archipiélago de Espíritu Santo; 25 = Balandra; 26 = Non-Such; 27 = Sierra La Laguna; 28 = Cabo Pulmo; 29 = Estero de San José del Cabo; and 30 = Cabo San Lucas.

Taxon	Natural Protected Areas																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Rhinocheilus lecontei	+	+	+			+	+	+	+	+	+																			
Salvadora hexalepis		+	+		+	+	+	+	+	+	+	+		+				+	+		+	+	+		+	+	+		+	+
Sonora annulata		+																												
*Sonora cincta***						+	+	+	+	+	+			+				+	+											
*Sonora fasciata***												+		+				+			+	+	+							
*Sonora mosaueri***			+							+								+				+	+							
*Sonora punctatissima***												+																		
*Sonora savagei***												+																		
*Sonora straminea***																											+			
Sonora semiannulata		+																												
Tantilla planiceps			+							+		+						+									+			
Trimorphodon lyrophanes			+		+				+	+	+	+						+				+	+		+		+		+	
Dipsadidae (7) species																														
Diadophis punctatus			+											+																
*Hypsiglena catalinae***												+																		
Hypsiglena chlorophaea		+																												
*Hypsiglena gularis***												+																		
*Hypsiglena marcosensis***												+																		
Hypsiglena ochrorhynchus			+		+	+	+	+	+	+	+	+		+				+	+		+	+	+		+	+	+		+	+
*Hypsiglena slevini***										+		+		+				+			+	+	+		+	+	+		+	+
Elapidae (1 species)																														
Hydrophis platurus												+		+	+	+	+			+				+				+		+
Leptotyphlopidae (2 species)																														
*Rena boettgeri***																									+		+		+	+
Rena humilis		+	+			+	+	+	+	+	+	+		+				+	+		+	+	+		+	+				
Natricidae (3 species)																														
Thamnophis elegans				+																										
Thamnophis hammondii	+		+	+	+					+								+												
*Thamnophis validus***																											+		+	
Typhlopidae (1 species)																														
*Indotyphlops braminus****																													+	
Viperidae (12 species)																														
*Crotalus angelensis***												+																		
Crotalus atrox		+										+																		
*Crotalus catalinensis***												+																		
Crotalus cerastes		+																												
*Crotalus enyo***									+	+	+	+		+				+	+		+	+	+		+	+	+		+	+
Crotalus helleri			+	+	+	+	+	+	+	+	+			+				+												
*Crotalus lorenzoensis***												+																		
*Crotalus mitchellii***												+		+				+	+		+	+	+	+	+	+	+	+	+	
*Crotalus polisi***												+																		
Crotalus pyrrhus	+		+		+	+	+	+	+	+	+	+																		
Crotalus ruber	+	+	+	+	+	+	+	+	+	+	+	+		+				+	+		+	+	+	+	+	+	+	+	+	
*Crotalus thalassoporus***												+																		
Testudines (8 species)																														

No. 53. *Crotalus ruber* Cope, 1892. The Red Diamond Rattlesnake is distributed from "Los Angeles County, California, south throughout Baja California to Cabo San Lucas…*Crotalus ruber* is known to occur on the Pacific islands of Cedros and Santa Margarita…and the Gulf islands of Angel de la Guarda, Danzante, Monserrat, Pond, San José, and San Marcos…" (Grismer 2002: 322). This individual was found at Rancho El Coyote, Sierra San Pedro Mártir. The species EVS was determined as 9, placing it at the upper limit of the low vulnerability category. The IUCN assessed its conservation staus as Least Concern (LC), and SEMARNAT judged it as a species of Special Protection (Pr). *Photo by Ivan Parr.*

No. 54. *Crotalus thalassoporus* Meik, Schaack, Flores-Villela, and Streicher, 2018. The Piojo Island Speckled Rattlesnake or Louse Island Speckled Rattlesnake is endemic to Isla Piojo in the Gulf of California, in the municipality of San Quintín. Its EVS was assessed as 19, placing it in the upper portion of the high vulnerability category. This species is not listed by the IUCN, but SEMARNAT lists it as a species of Special Protection (Pr). *Photo by Tim Warfel.*

No. 55. *Actinemys pallida* (Seeliger, 1945). The Southwestern Pond Turtle ranges from the central coast range south of the San Francisco Bay area to northwestern Baja California (http://www.reptile-database.org/, accessed 7 December 2022; Grismer 2002: 88), with a disjunct population in the central desert of Baja California (Valdez-Villavicencio et al. 2016). This individual came from Arroyo Valladares, Baja California, in the municipality of San Quintín. In this study its EVS was assessed as 13, placing it at the higher limit of the medium vulnerability category. This species is not listed by either the IUCN or SEMARNAT. *Photo by Jorge H. Valdez-Villavicencio.*

Table 21 (continued). Distribution of herpetofaunal species in the Natural Protected Areas of the Baja California Peninsula, Mexico. Abbreviations are as follows: * = species endemic to Mexico; ** = species endemic to Baja California; and *** = non-native species. The numbers of the Natural Protected Areas signify the following: 1 = Constitución de 1857; 2 = Alto Golfo y Delta del Río Colorado; 3 = Arroyo San Miguel; 4 = Sierra San Pedro Mártir; 5 = Los Montes de San Pedro; 6 = Reserva Natural San Quintín; 7 = Reserva Natural Punta Mazo; 8 = Reserva Natural Monte Ceniza; 9 = Reserva Natural Valle Tranquilo; 10 = Valle de los Cirios; 11 = Costa Salvaje Wildlands; 12 = Islas del Golfo de California; 13 = Isla Guadalupe; 14 = Islas del Pacífico de la Península de Baja California; 15 = Zona Marina del Archipielago de San Lorenzo; 16 = Zona Marina Bahía de los Ángeles, Canales de Ballenas y Salsipuedes; 17 = Complejo Lagunar Ojo de Liebre; 18 = El Vizcaíno; 19 = Servidumbre Ecológica Rancho San Cristóbal-Majiben; 20 = Bahía de Loreto; 21 = Reserva Ecológica Llanos de Magdalena; 22 = Reserva Natural El Portezuelo; 23 = Santa Martha; 24 = Zona marina del Archipiélago de Espíritu Santo; 25 = Balandra; 26 = Non-Such; 27 = Sierra La Laguna; 28 = Cabo Pulmo; 29 = Estero de San José del Cabo; and 30 = Cabo San Lucas.

Taxon	Natural Protected Areas																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Cheloniidae (4 species)																														
Caretta caretta												+		+	+	+	+			+				+				+		+
Chelonia mydas												+		+	+	+	+			+				+				+		+
Eretmochelys imbricata												+		+	+	+	+			+				+				+		+
Lepidochelys olivacea												+		+	+	+	+			+				+				+		+
Dermochelyidae (1 species)																														
Dermochelys coriacea												+		+	+	+	+			+				+				+		+
Emydidae (3 species)																														
Actinemys marmorata				+	+					+																				
*Trachemys nebulosa***																		+											+	
*Trachemys scripta****																													+	
Total (157 species)																														

eventually be located within one or more of the NPAs.

The most widely distributed species among the NPAs is the phrynosomatid lizard *Uta stansburiana*, which has been recorded from 25 of these areas. A sizeable number of species (69 or 43.9%) have been recorded from only one of the 30 NPAs (Table 21). The remaining 90 species (57.3%) have been recorded in two to 24 NPAs.

In 29 of the 30 NPAs from which herpetofaunal species have been recorded, the total numbers of species range from six to 84 (Table 22). The allocations of these species according to their distributional status are shown in Table 22. Most of the 29 NPAs (22 or 75.9%) lack non-native species, which is a desirable feature. The other seven NPAs support from one to four non-native species ($\bar{x}$ = 1.7 species). Each of the 29 NPAs have a herpetofauna that contains some number of non-endemic species, which ranges from six to 40. Most of these NPAs also have some country endemic species, ranging from one to 50; however, no country endemic species have been recorded in eight of these areas. Usually the number of non-endemic species exceeds that of the country endemics, except for the Gulf of California Islands (with 32 of the former and 50 of the latter), the Sierra La Laguna (with 18 of the former and 20 of the latter), and the Estero de San José del Cabo (with 15 of each of non-endemic and country endemic species).

Only one of the 30 NPAs in the Baja California Peninsula and its adjacent islands (Isla Guadalupe) lacks a herpetofaunal survey of any magnitude. This island is located 241 km off the western coast of the peninsula and about 400 km southwest of Ensenada in the state of Baja California. This island and its surrounding islets and waters are part of a biosphere reserve established in 2005 (Table 20). The absence of herpetofaunal documentation on Isla Guadalupe is not due to a lack of effort on the part of herpetologists, as several collecting efforts have been made. For example, the San Diego Natural History Museum sponsored an expedition there years ago, and two authors of this paper (APG and JHVV) also have been on this island and contacted people who are part of an NGO at a base camp. However, none of these efforts resulted in the finding of any amphibians or reptiles on Isla Guadalupe; therefore, it is interesting that apparently no amphibians, and especially no reptiles, have made it to this island.

Of the 81 non-endemic species found in the herpetofauna of the peninsula and its associated islands, 75 (92.6%) have been recorded among the region's NPAs. Of the 77 country endemic species known, 76 (98.7%) are established in protected areas. Fortunately, only seven of the 14 non-native species (50%) have populations established in any of the NPAs, and usually they occur individually in any given area. Only one of these seven non-native species (*Hemidactylus frenatus*) occurs in more than a single NPA, and the number of areas it occurs in is six (Table 21).

The Baja California Peninsula is a unique area of Mexico, as nearly 30% of its land is protected. However, comprehensive herpetological studies are still lacking for most reserves, and the available surveys largely focus on target species (endemics and NOM-59 species). Since several conservation threats affect the natural protected

Table 22. Summary of the distributional status of the herpetofaunal species in protected areas in the Baja California Peninsula, Mexico, and adjacent islands. Total = total number of species recorded in a compendium of the listed protected areas.

Protected area	Number of species	Distributional status		
		Non-endemic (NE)	Country Endemic (CE)	Non-native (NN)
Constitución de 1857	26	26	—	—
Alto Golfo y Delta del Río Colorado	28	27	—	1
Arroyo San Miguel	31	30	1	—
Sierra San Pedro Mártir	21	21	—	—
Los Montes de San Pedro	26	26	—	—
Reserva Natural San Quintín	21	17	4	—
Reserva Natural Punta Mazo	22	17	5	—
Reserva Natural Monte Ceniza	21	17	4	—
Reserva Natural Valle Tranquilo	31	25	6	—
Valle de los Cirios	54	40	14	—
Costa Salvaje Wildlands	32	24	8	—
Islas del Golfo de California	84	32	50	2
Islas del Pacífico de la Península de Baja California	43	29	14	—
Zona Marina del Archipielago de San Lorenzo	6	6	—	—
Zona Marina Bahía de los Ángeles, Canales de Ballenas y Salsipuedes	6	6	—	—
Complejo Lagunar Ojo de Liebre	6	6	—	—
El Vizcaíno	48	30	16	2
Servidumbre Ecológica Rancho San Cristóbal-Majiben	24	14	10	—
Bahía de Loreto	9	9	—	—
Reserva Ecológica Llanos de Magdalena	26	16	10	—
Reserva Natural El Portezuelo	31	21	10	—
Santa Martha	30	21	9	—
Zona marina del Archipiélago de Espíritu Santo	8	7	1	—
Balandra	31	20	11	—
Non-Such	26	16	10	—
Sierra La Laguna	39	18	20	1
Cabo Pulmo	10	8	1	1
Estero de San José del Cabo	34	15	15	4
Cabo San Lucas	30	17	12	1
Total	**157**	**75**	**76**	**7**

areas, a substantial amount of work is necessary to achieve effective resource management and ensure the conservation of the amphibian and reptile species in the Baja California Peninsula, both inside and outside of the NPAs.

Conclusions and Recommendations

Conclusions

A. The herpetofauna of the Baja California Peninsula is comprised of 172 species, including 18 anurans, three salamanders, 140 squamates (83 lizards and 57 snakes), and 11 turtles.
B. The numbers of species known from the 10 geographic regions we recognize in the Baja California Peninsula range from 27 in the Baja California Coniferous Forest Region to 84 in the Gulf Islands Region. The species occupy from one to 10 geographic regions, with a mean number of 3.3.
C. The number of species shared among the 10 geographic regions ranges from eight between the BCCFR and SLLR regions to 54 between the CGCR and ATR regions. The Coefficient of Biogeographic Resemblance values range from 0.16 between BCCFR and GIR to 0.86 between CGCR and ATR. The UPGMA dendrogram (Fig. 24) demonstrates that the two most closely related regions are the Central Gulf Coast Region and the Arid Tropical Region, which are joined at the 0.86 level. These two regions are joined at the 0.82 level with the Magdalena Region. These three regions are joined at the 0.74 level with the Vizcaíno Region. These four regions are joined at the 0.64 level with the Sierra La Laguna Region. This group of five regions in the southern portion of the Peninsula is joined to the remaining regions in the northern portion of the Peninsula and those in the Pacific Ocean and the Gulf of California at the 0.52 level. Of the remaining five regions, the ones most closely allied are the Pacific

Islands Region and the California Region, joined at the 0.62 level. These two regions are united to the other three regions at the 0.51 level with the Lower Colorado Valley Region. The eight previously mentioned peninsular regions are joined to the Gulf Islands Region at the 0.44 level. Finally, the most distantly related region is the Baja California Coniferous Forest Region, which is joined to all the other regions at the 0.33 level.

D. The level of herpetofaunal endemism in the Baja California Peninsula is relatively high. Of the 158 species that make up the native herpetofauna, 77 are peninsular endemics (48.7%).

E. The distributional status of the species that comprise the herpetofauna of the Baja California Peninsula is as follows (in order of category size): non-endemics (81, 47.1%); peninsular endemics (77, 43.6%); and non-natives (14, 8.1%).

F. With respect to the distributional categories instituted by Wilson et al. (2017), of the 81 non-endemic species, 74 (91.4%) are in the MXUS category, with one (1.2%) in the USCA category and six (7.4%) in the OCEA category.

G. The principal environmental threats are land conversion and habitat loss, water diversion and overuse, invasive species, livestock grazing, illegal trade, off-road activities, infectious diseases, and climate change.

H. To evaluate the conservation status of the herpetofauna of the Baja California Peninsula, we used the SEMARNAT, IUCN, and EVS systems. SEMARNAT lists 85 (53.8%) of the 158 native species, including seven categorized as endangered (P), 33 as threatened (A), and 45 as special protection (Pr). A comparison of the SEMARNAT and distributional categorizations demonstrates that of the seven endangered species, all are non-endemics; of the 33 threatened species, 13 are non-endemics and 20 are peninsular endemics; and of the 45 special protection species, 19 are non-endemics and 26 are peninsular endemics.

I. Application of the IUCN conservation status evaluation categories to the herpetofauna of the Baja California Peninsula indicates the following distribution (by category and proportion): CR (three, 1.9%); EN (four, 2.5%); VU (eight, 5.1%); NT (seven, 4.4%); LC (108, 68.4%); DD (three, 1.9%); and NE (25, 15.8%).

J. Application of the EVS system of conservation assessment to the 152 non-marine native species of the Baja California Peninsula indicates that the categorical values increase from low scores (28 species, 18.4%) to medium scores (48 species, 31.6%), and then to high scores (76 species, 50.0%).

K. A comparison of the IUCN and EVS conservation status categorizations indicates that nine (11.8%) of the 76 high vulnerability species (by EVS) are allocated to one of the three IUCN "threat categories" (CR, EN, or VU), and that 26 (92.9%) of the 28 low vulnerability species are placed in the LC category.

L. Application of the Relative Herpetofauna Priority (RHP) measure demonstrates that the most significant herpetofauna in the Baja California Peninsula is that of the Gulf Islands Region, inasmuch as it contains the highest numbers of peninsular endemic species and high vulnerability species. The ratings of seven of the 10 geographic regions are the same whether based on peninsular endemic species or high vulnerability species.

M. Thirty protected areas are established in the Baja California Peninsula, with 17 administered at the federal level, two at the state level, and 11 at the private level. The 30 protected areas comprise almost one-half of the total area of the Baja California Peninsula.

N. Of the 158 species that comprise the native herpetofauna of the Baja California Peninsula, only eight (two country endemics and six non-endemics) are not represented in the system of protected areas in the region. Of the 30 established NPAs, only one (Isla Guadalupe) is not known to contain any herpetofaunal species.

O. The most widely distributed species represented with the system of NPAs is the lizard *Uta stansburiana*, which occupies 25 of the 29 supporting herpetofaunal populations. Sixty-nine species are known from only a single NPA, while 90 species occupy from two to 24 NPAs.

P. The total numbers of species occupying the 29 NPAs range from six to 84. Twenty-two of the 29 NPAs support no non-native species, which is a desirable feature. A typical NPA supports more non-native than country endemic species.

Q. Of the 83 non-endemic species recorded on the peninsula and its associated islands, 75 (90.4%) are known from among the region's NPAs; of the 77 country endemics, 76 (98.7%) are represented. The total representation is 151 of 158 species, or 95.6%, which is outstanding from a conservation perspective. Also, of major interest from this perspective, nearly 30% of the area in the Baja California Peninsula is protected, even though herpetofaunal surveys are unavailable for most of the NPAs.

Recommendations

A. Prioritize the evaluation of species to be included in NOM-059-SEMARNAT, based on those that have high vulnerability EVS values, especially peninsular endemics.

B. Promote eradication programs for non-native species, as both states in the peninsula have the highest numbers of non-native amphibian and reptile species in Mexico. These control and eradication efforts are important to avoid future detrimental effects on native species of amphibians and reptiles.
C. Evaluate changes to the EVS criteria in order to consider regional threats that affect species of amphibians in desert areas.
D. Because herpetofaunal surveys have not been conducted in many of the protected areas, this remains a major goal for these areas in the future. Achieving this goal will require a determination of the presence or absence of the eight native species that are not represented within the system of protected areas.
E. Once the entire native herpetofauna is demonstrated to occur within the confines of the system of protected areas, monitoring programs can be established to continually assess the health of the populations of all species.

"In a country with phenomenal natural riches, Baja California and its offshore islands stand out as a priceless setting for studying the factors that shape ecological communities, and they are replete with stunningly beautiful locales for recreation and education."

Harry W. Greene (Foreword in Grismer, 2002)

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Literature Cited

Adams A, Peralta-García A, Flores-López CA, Valdez-Villavicencio JH, Briggs CJ. 2022. High fungal pathogen loads and prevalence in Baja California amphibian communities: the importance of species, elevation, and historical context. *Global Ecology and Conservation* 33: e01968.

Adams AJ, Pessier AP, Briggs CJ. 2017. Rapid extirpation of a North American frog coincides with an increase in fungal pathogen prevalence: historical analysis and implications for reintroduction. *Ecology and Evolution* 7: 10,216–10,232.

Aguirre-Muñoz A, Samaniego-Herrera A, Luna-Mendoza L, Ortiz-Alcaraz A, Méndez-Sánchez F, Hernández-Montoya J. 2016. La restauración ambiental exitosa de las islas de México: una reflexión sobre los avances a la fecha y los retos por venir. Pp. 485–512 In: *Experiencias Mexicanas en la Restauración de los Ecosistemas*. Editors, Ceccon E, Martínez-Garza C. UNAM, CRIM, UAEM and CONABIO, México, DF, Mexico. 577 p.

Álvarado-Díaz J, Suazo-Ortuño I, Wilson LD, Medina-Aguilar O. 2013. Patterns of physiographic distribution and conservation status of the herpetofauna of Michoacán, Mexico. Contribution to Special Mexico Issue. *Amphibian & Reptile Conservation* 7: 128–170 (e71).

Álvarez-Borrego S. 2002. Physical oceanography. Pp. 41–59 In: *A New Island Biogeography of the Sea of Cortés*. Editors, Case TJ, Cody ML, Ezcurra E. Oxford University Press, New York, New York, USA. 690 p.

Alves-Ferreira G, Talora DC, Solé M, Cervantes-López MJ, Heming NM. 2022. Unraveling global impacts of climate change on amphibian distributions: a life-history and biogeographic-based approach. *Frontiers in Ecology and Evolution* 10: 987237.

Arguelles-Méndez C, Ortega-Rubio A, Romero-Schmidt H, Coria-Benet R, Solis-Marín F. 1996. Pacific Treefrog population changes as a response to the absence of livestock grazing. *Herpetology* 26: 1–4.

Arnaud G, Martins M, Burguete-Trujillo L, Hernández-Rodríguez I, Avila-Villegas H, Murillo-Quero R, Quijada-Mascareñas A. 2008. Historia natural de las serpientes de cascabel *Crotalus catalinensis*, endémica de la isla Santa Catalina, Golfo de California, México. Pp. 93–100 In: *Estudios de las Islas del Golfo de California*. Editor, Flores-Campaña LM. Universidad Autónoma de Sinaloa-Gobierno del Estado de Sinaloa-Consejo Nacional de Ciencia y Tecnología, México, DF, Mexico. 252 p.

Arriaga L. 2006. La península de Baja California: biodiversidad, conservación y manejo de sus recursos vegetales. Pp. 64–84 In: *Manejo, Conservación y Restauración de Recursos Naturales en México*. Coordinators, Oyama K, Castillo A. Siglo XXI, México, DF, Mexico. 368 p.

Auliya M, Altherr S, Ariano-Sánchez D, Baard EH, Brown C, Brown RM, Ziegler T. 2016. Trade in live reptiles, its impact on wild populations, and the role of the European market. *Biological Conservation* 204: 103–119.

Badan-Dangon A, Robles JM, García J. 1989. Poleward flows off Mexico's Pacific coast. Pp. 176–202 In: *Poleward Flows Along Eastern Ocean Boundaries. Coastal and Estuarine Studies, 34.* Editors, Neshyba SJ, Mooers CNK, Smith RL, Barber RT. Springer, New York, New York, USA. 374 p.

Ballesteros-Barrera C, Tapia-Pérez O, Zárate-Hernández R, Leyte-Manrique A, Martínez-Bernal A, Vargas-Miranda B, Martínez-Coronel M, Ortiz-Burgos S. 2022. The potential effect of climate change on the distribution of endemic anurans from Mexico's

Tropical Dry Forest. *Diversity* 14: 650.
Barragan-Vázquez MDR, Ríos Rodas L, Fucsko LA, Porras LW, Mata-Silva V, Rocha A, DeSantis DL, García-Padilla E, Johnson JD, Wilson LD. 2022. The herpetofauna of Tabasco, Mexico: composition, distribution, and conservation status. *Amphibian & Reptile Conservation* 16(2) [General Section]: 1–61 (e315).
Bellard C, Bertelsmeier C, Leadley P, Thuiller W, Courchamp F. 2012. Impacts of climate change on the future of biodiversity. *Ecology Letters* 15: 365–377.
Bellard C, Leclerc C, Courchamp F. 2013. Impact of sea level rise on the 10 insular biodiversity hotspots. *Global Ecology and Biogeography* 23: 203–212.
Bellard C, Marino C, Courchamp F. 2022. Ranking threats to biodiversity and why it doesn't matter. *Nature Communications* 13: 2,616.
Blackburn TM, Bellard C, Ricciardi A. 2019. Alien versus native species as drivers of recent extinctions. *Frontiers in Ecology and the Environment* 17: 203–207.
Blaustein AR, Walls SC, Bancroft BA, Lawler JJ, Searle CL, Gervasi SS. 2010. Direct and indirect effects of climate change on amphibian populations. *Diversity* 2: 281–313.
Böhm M, Collen B, Baillie JEM, Bowles P, Chanson J, Cox N, Hammerson G, Hoffmann M, Livingstone SR, Ram M, et al. 2013. The conservation status of the world's reptiles. *Biological Conservation* 157: 372–385.
Bolom-Huet R, Pineda E, Díaz-Fleischer F, Muñoz-Alonso AL, Galindo-González J. 2019. Known and estimated distribution in Mexico of *Batrachochytrium dendrobatidis*, a pathogenic fungus of amphibians. *Biotropica* 51: 731–746.
Bostic DL. 1971. Herpetofauna of the Pacific coast of north central Baja California, Mexico, with a description of a new subspecies of *Phyllodactylus xanti*. *Transactions of the San Diego Society of Natural History* 16: 237–264.
Bury RB, Luckenbach RA, Busack SD. 1977. *Effects of Off-road Vehicles on Vertebrates in the California Desert. Wildlife Research Report Number 8*. United States Fish and Wildlife Service, Washington, DC, USA. 23 p.
Bury RB, Welsh HH, Germano DJ, Ashton DT. 2012. *Western Pond Turtle: Biology, Sampling Techniques, Inventory and Monitoring, Conservation, and Management. Northwest Fauna Number 7*. Society for Northwestern Vertebrate Biology, Olympia, Washington, USA. 128 p.
Busack SD, Bury RB. 1974. Some effects of off-road vehicles and sheep grazing on lizard populations in the Mojave Desert. *Biological Conservation* 6: 179–183.
Carrillo-Guerrero Y. 2010. *Diagnostico de la Cuenca de La Paz. Reporte Final*. Niparajá-Pronatura Noroeste. La Paz, Baja California Sur, Mexico. 42 p.
Carter ET, Eads BC, Ravesi MJ, Kingsbury BA. 2015. Exotic invasive plants alter thermal regimes: implications for management using a case study of a native ectotherm. *Functional Ecology* 29: 683–693.
Cox CL, Davis-Rabosky AR, Holmes IA, Reyes-Velasco J, Roelke CE, Smith EN, Flores-Villela O, McGuire JA, Campbell JA. 2018. Synopsis and taxonomic revision of three genera in the snake tribe Sonorini. *Journal of Natural History* 52: 945–988.
Cox N, Young BE, Bowles P, Fernandez MF, Marin J, Rapacciuolo G, Böhm M, Brooks TM, Hedges SB, Hilton-Taylor C, et al. 2022. A global reptile assessment highlights shared conservation needs of tetrapods. *Nature* 605: 285–290.
Cruz-Elizalde R, Ramírez-Bautista A, Pineda-López R, Mata-Silva V, DeSantis DL, García-Padilla E, Johnson JD, Fucsko LA, Wilson LD. 2022. The herpetofauna of Querétaro, Mexico: composition, distribution, and conservation status. *Amphibian & Reptile Conservation* 16(1) [General Section]: 148–192 (e308).
Cruz-Sáenz D, Muñoz-Nolasco FJ, Mata-Silva V, Johnson JD, García-Padilla E, Wilson LD. 2017. The herpetofauna of Jalisco, Mexico: composition, distribution, and conservation status. *Mesoamerican Herpetology* 4: 22–118.
Delgadillo J. 2004. *El Bosque de Coníferas de la Sierra San Pedro Mártir, Baja California, México*. Instituto Nacional de Ecología, SEMARNAT, México, DF, Mexico. 159 p.
DOF (Diario Oficial de la Federación). 2020. Disponibilidad de agua en Baja California Sur. Comisión Estatal del Agua de Baja California Sur. Available: https://cea.bcs.gob.mx/acuiferos/ [Accessed: 5 December 2022].
Frost DR. 2022. Amphibian Species of the World: an Online Reference. Version 6.0. American Museum of Natural History, New York, New York, USA. Available: https://amphibiansoftheworld.amnh.org [Accessed: 6 December 2022].
Gaeta-Verdín MC. 2020. Efecto de las actividades de vehículos fuera de camino en el paisaje de Baja California. Master's Thesis. Centro de Investigación Científica y Educación Superior de Ensenada, Ensenada, México. 119 p.
Galina-Tessaro P, López-Acosta D, Álvarez-Cárdenas S, Valdez-Villavicencio JH, Breceda A, Arnaud GF, Rivera J, Coria BR. 2015. *Contribución a la Distribución, Ecología y Estado de Conservación de dos Especies del Género Sceloporus, Endémicas de la Región del Cabo, Baja California Sur. Informe final SNIB-CONABIO, proyecto No. HK012*. Centro de Investigaciones Biológicas del Noroeste, México, DF, Mexico. 113 p.
García RA, Clusella-Trullas S. 2019. Thermal landscape change as a driver of ectotherm responses to plant

invasions. *Proceedings of the Royal Society B* 286: 20191020.

Garcillán PP, González-Abraham C, Ezcurra E. 2012. Phytogeography, vegetation, and ecological regions. Pp. 23–34 In: *Baja California Plant Field Guide*. 3rd Edition. Editors, Rebman JP, Roberts NC. San Diego Natural History Museum, San Diego, California, USA. 480 p.

Gatica-Colima AB. 1998. Herpetofauna y vegetación de un gradiente de perturbación en las dunas costeras de San Felipe, Baja California, México. Master's Thesis. Facultad de Ciencias, Universidad Autónoma de Baja California, Ensenada, BC, México.

Gibbons JF, Scott DE, Ryan TJ, Buhlmann KA, Tuberville TD, Metts BS, Greene JL, Mills T, Leiden Y, Poppy S, et al. 2000. The global decline of reptiles, déjà vu amphibians. *Bioscience* 50: 653–666.

González-Abraham CE, Garcillán PP, Ezcurra E, Grupo de Trabajo Ecorregiones. 2010. Ecorregiones de la península de Baja California: una síntesis. *Boletín de la Sociedad Botánica de México* 87: 69–82.

González-Sánchez VH, Johnson JD, García-Padilla E, Mata Silva V, DeSantis DL, Wilson LD. 2017. The herpetofauna of the Mexican Yucatan Peninsula: composition, distribution, and conservation. *Mesoamerican Herpetology* 4: 263–380.

González-Sánchez VH, Johnson JD, González-Solís D, Fucsko LA, Wilson LD. 2021. A review of the introduced herpetofauna of Mexico and Central America, with comments on the effects of invasive species and biosecurity methodology. *ZooKeys* 1022: 79–154.

González-Zamorano P, Nava-Sánchez EH, León-de la Luz JL, Díaz-Castro SC. 2011. Patrones de distribución y determinantes ambientales de los mangles peninsulares. Pp. 67–102 In: *Los Mangles de la Peninsula de Baja California*. Editors, Félix-Pico EF, Serviere-Zaragoza E, Riosmena-Rodríguez R, León-de la Luz JL. CICIMAR, CIBNOR y UABCS, México, DF, Mexico. 326 p.

Goode MJ, Swann DE, Schwalbe CR. 2004. Effects of destructive collecting practices on reptiles: a field experiment. *Journal of Wildlife Management* 68: 429–434.

Goode MJ, Horrace WC, Sredl MJ, Howland JM. 2005. Habitat destruction by collectors associated with decreased abundance of rock-dwelling lizards. *Biological Conservation* 125: 47–54.

Graciano JC. 2013. Uso del agua y agricultura de exportación en Baja California Sur. Perspectivas desde el agro para el desarrollo regional. Master's Thesis. Universidad Autonoma de Baja California Sur, Ensenada, BC, Mexico. 177 p.

Grismer LL. 1994. The origin and evolution of the peninsular herpetofauna of Baja California, México. *Herpetological Natural History* 2: 51–106.

Grismer LL. 2002. *Amphibians and Reptiles of Baja California, including Its Pacific Islands and the Islands in the Sea of Cortés*. University of California Press, Berkeley, California, USA. xii + 399 p.

Grismer LL, McGuire JA. 1993. The oases of central Baja California, México. Part I. A preliminary account of the relict mesophilic herpetofauna and the status of the oases. *Bulletin of the Southern California Academy of Sciences* 92: 2–24.

Hastings JR, Turner RM. 1965. Seasonal precipitation regimes in Baja California, México. *Geografiska Annaler* 47A: 204–223.

Haynes E, Pohly A, Clifford DL, Patterson LC, Manning S, Wack RF, Allender MC. 2021. First report of ophidiomycosis in a free-ranging California Kingsnake (*Lampropeltis californiae*) in California, USA. *Journal of Wildlife Diseases* 57: 246–249.

Heimes P. 2016. *Snakes of Mexico. Herpetofauna Mexicana. Volume 1*. Edition Chimaira, Frankfurt am Main, Germany, and ECO Publishing, Rodeo, New Mexico, USA. 572 p.

Hickey B. 1979. The California current system: hypotheses and facts. *Progress in Oceanography* 8: 191–279.

Holland DC. 1994. *The Western Pond Turtle: Habitat and History. Final Report*. United States Department of Energy, Portland, Oregon, USA. 303 p.

Hollingsworth BD, Mahrdt CR, Grismer LL, Banta BD, Sylber CK. 1997. The occurrence of *Sauromalus varius* on a satellite islet of Isla Salsipuedes, Gulf of California, México. *Herpetological Review* 28: 26–28.

Hollingsworth BD, Mahrdt CR, Grismer LL, Lovich RE. 2015. Herpetofauna of Baja California. Pp. 15–33 In: *Amphibians and Reptiles of the US-Mexico Border States/Anfibios y reptiles de los estados de la frontera México-Estados Unidos*. Editor, Lemos-Espinal JA. Texas A&M University Press, College Station, Texas, USA. 614 p.

Humphrey RR. 1974. *The Boojum and its Home*. University of Arizona Press, Tucson, Arizona, USA. 214 p.

Jaramillo V. 1994. *Revegetación y Reforestación de las Áreas Ganaderas en las Zonas Áridas y Semiáridas de México*. Secretaria de Agricultura y Recursos Hidráulicos, Subsecretaria de Ganadería, Comisión Técnico Consultiva de Coeficientes de Apostadero. México, DF, Mexico. 48 p.

Jennings MR, Hayes MP. 1994. *Amphibian and Reptile Species of Special Concern in California*. California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, California, USA. 255 p.

Jofré GM, Reading CJ. 2012. An assessment of the impact of conservation grazing on reptile populations. *Amphibian and Reptile Conservation Research Report* 12/01: 1-48.

Johnson, JD, Mata-Silva V, García-Padilla E, Wilson LD. 2015 The herpetofauna of Chiapas, Mexico:

composition, distribution, and conservation. *Mesoamerican Herpetology* 2: 271–329.

Kats LB, Ferrer RP. 2003. Alien predators and amphibian declines: review of two decades of science and transition to conservation. *Diversity and Distributions* 9: 99–110.

Kurczyn JA, Pérez-Brunius P, López M, Candela J, Delgadillo-Hinojosa F, García-Mendoza E. 2019. Water masses and ocean currents over the continental slope off northern Baja California. *Journal of Geophysical Reserch: Oceans* 124: 2,803–2,823.

Lambert MR, Hernández-Gómez O, Krohn AR, Mutlow A, Patterson LC, Rosenblum EB, Timmer M, Willis J, Bushell J. 2021. Turtle shell disease fungus (*Emydomyces testavorans*): first documented occurrence in California and prevalence in free-living turtles. *Ichthyology & Herpetology* 109: 958–962.

Lara-Reséndiz RA, Galina-Tessaro P, Pérez-Delgadillo AG, Valdez Villavicencio JH, Méndez-de la Cruz FR. 2019. Efectos del cambio climático en una especie de lagartija termófila de amplia distribución (*Dipsosaurus dorsalis*): un enfoque ecofisiológico. *Revista Mexicana de Biodiversidad* 90: e902888.

Lara-Reséndiz RA, Galina-Tessaro P, Sinervo B, Miles DB, Valdez-Villavicencio JH, Valle-Jiménez FI, Méndez-de la Cruz FR. 2020. How will climate change impact fossorial lizard species? Two examples in the Baja California Peninsula. *Journal of Thermal Biology* 95: 102811.

Lara-Reséndiz RA, Rosen PC, Sinervo B, Miles DB, Mendez-de la Cruz FR. 2022. Habitat thermal quality for *Gopherus evgoodei* in tropical deciduous forest and consequences of habitat modification by buffelgrass. *Journal of Thermal Biology* 104: 103192.

Lavín MF, Marinone SG. 2003. An overview of the physical oceanography of the Gulf of California. Pp. 173–204 In: *Nonlinear Processes in Geophysical Fluid Dynamics*. Editors, Velasco Fuentes OU, Sheinbaum J, Ochoa J. Springer, Dordrecht, Germany. 376 p.

Lazcano D, Nevárez-de los Reyes M, García-Padilla E, Johnson JD, Mata-Silva V, DeSantis DL, Wilson LD. 2019. The herpetofauna of Coahuila, Mexico: composition, distribution, and conservation status. *Amphibian & Reptile Conservation* 13(2) [General Section]: 31–94 (e189).

Leaché AD, Koo MS, Spencer CL, Papenfuss TJ, Fisher RN, McGuire JA. 2009. Quantifying ecological, morphological, and genetic variation to delimit species in the Coast Horned Lizard species complex (*Phrynosoma*). *Proceedings of the National Academy of Sciences of the United States of America* 106: 12,418–12,423.

Leclère D, Obersteiner M, Barrett M, Butchart SHM, Yung L. 2020. Bending the curve of terrestrial biodiversity needs an integrated strategy. *Nature* 585: 551–556.

Leyte-Manrique A, Mata-Silva V, Báez-Montes O, Fucsko LA, DeSantis DL, García-Padilla E, Rocha A, Johnson JD, Porras LW, Wilson LD. 2022. The herpetofauna of Guanajuato, Mexico: composition, distribution, and conservation status. *Amphibian & Reptile Conservation* 16(2) [General Section]: 133–180 (e321).

Lovich LE, Grismer LL, Danemann G. 2009. Conservation status of the herpetofauna of Baja California, México and associated islands in the Sea of Cortez and Pacific Ocean. *Herpetological Conservation and Biology* 4: 358–378.

Lowe S, Browne M, Boudjelas S, De Poorter M. 2000. *100 of the World's Worst Invasive Alien Species. A Selection from the Global Invasive Species Database of the Species Specialist Group (ISSG) a specialist group of the Species Survival Commission (SSC)*. World Conservation Union (IUCN), Gland, Switzerland. 12 p.

Luja VH, Rodríguez-Estrella R, Ratzlaff K, Parra-Olea G, Ramírez-Bautista A. 2012. The chytrid fungus *Batrachochytrium dendrobatidis* in isolated populations of the Baja California Treefrog *Pseudacris hypochondriaca curta* in Baja California Sur, Mexico. *Southwestern Naturalist* 57: 323–327.

Luja VH, Rodríguez-Estrella R, Rojas-González RI. 2016. Reproducción y abundancia de la rana arborícola de Baja California *Pseudacris hypochondriaca curta* (Anura: Hylidae) en oasis de Baja California Sur. Pp. 77–100 In: *Ecología y Conservación de Anfibios y Reptiles de México. Publicación Especial No. 4.* Editors, Gutiérrez-Mayen MG, Ramírez-Bautista A, Pineda E. Sociedad Herpetológica Mexicana, México, DF, Mexico. 396 p.

Mahrdt CR, Beaman KR, Valdez-Villavicencio JH, Papenfuss TJ. 2022. *Bipes biporus* (Five-toed Worm Lizard). *Catalogue of American Amphibian and Reptiles* 930: 1–39.

Manrriquez-Gomez FJ, González-Gutiérrez NS, Ortiz-Serrato L, Moreno-Higareda HR, Valdez-Villavicencio JH. 2021. Anfibios y reptiles del Estero de Punta Banda, Ensenada, Baja California, México. *Revista Latinoamericana de Herpetología* 4: 74–84.

Markham CG. 1972. Baja California's climate. *Weatherwise* 25: 66–101.

Marshall BM, Strine C, Hughes AC. 2020. Thousands of reptile species threatened by under-regulated global trade. *Nature Communications* 11: 4,738.

Mata-Silva V, Johnson JD, Wilson LD, García-Padilla E. 2015. The herpetofauna of Oaxaca, Mexico: composition, physiographic distribution, and conservation. *Mesoamerican Herpetology* 2: 5–62.

Mata-Silva V, Fucsko LA, Gatira Colima AB, Nevárez-de los Reyes M, Lazcano D, Valdez Villavicencio J, Porras LW, DeSantis DL, Rocha A, Johnson JD, et al. [In press]. Biological connections: the uncertain future of the threatened U.S.-Mexico border region herpetofauna. *Zootaxa* [In Press].

Meigs P. 1966. Geography of coastal deserts. *Arid Zone Research* 28: 1–140.

Meik JM, Streicher JW, Lawing AM, Flores-Villela O, Fujita MK. 2015. Limitations of climatic data for inferring species boundaries: insights from Speckled Rattlesnakes. *PLoS One* 10: e0131435.

Meiri S, Bauer AM, Chirio L, Colli GR, Das I, Doan TM, Feldman A, Castro-Herrera F, Novosolov M, Pafilis P, et al. 2013. Are lizards feeling the heat? A tale of ecology and evolution under two temperatures. *Global Ecology and Biogeography* 22: 834–845.

Mellink E. 1995. The potential effect of commercialization of reptiles from Mexico's Baja California peninsula and its associated islands. *Herpetological Natural History* 3: 95–99.

Mellink E, Contreras J. 2014. Impacts of ranching on wildlife in Baja California. In: *Conservation Science in Mexico's Northwest: Ecosystem Status and Trends in the Gulf of California*. Editors, Wehncke EV, Lara-Lara JR, Álvarez-Borrego S, Ezcurra E. University of California Institute for Mexico and the United States (UC MEXUS) and Instituto Nacional de Ecología y Cambio Climático (INECC), México, DF, Mexico. 550 p.

Munguía-Vega A, Rodríguez-Estrella R, Shaw WW, Culver M. 2013. Localized extinction of an arboreal desert lizard caused by habitat fragmentation. *Biological Conservation* 157: 11–20.

Murray S, Shedd JD, Dugan EA. 2015. *Hypsiglena slevini*. Geographic distribution. *Herpetological Review* 46: 62.

Nevárez-de los Reyes M, Lazcano D, García-Padilla E, Mata-Silva V, Johnson JD, Wilson LD. 2016. The herpetofauna of Nuevo León, Mexico: composition, distribution, and conservation. *Mesoamerican Herpetology* 3: 557–638.

Pampa-Ramírez JT. 2021. Propuesta de manejo para la conservación de la culebra real de Todos Santos (*Lampropeltis zonata herrerae*) en Ensenada Baja California, México. Master's Thesis. Facultad de Ciencias, Universidad Autónoma de Baja California, Ensenada, BC, Mexico. 130 p.

Pase CP. 1982. Sierran montane conifer forest. Pp. 49–51 In: *Biotic Communities of the American Southwest: United States and Mexico*. Editor, Brown DE. University of Arizona for the Boyce Thompson Southwestern Arboretum, Tucson, Arizona, USA. 342 p.

Peinado M, Alcaraz F, Delgadillo J, Aguado I. 1994. Fitogeografía de la peninsula de Baja California, México. *Anales del Jardín Botánico de Madrid* 51: 255–277.

Peralta-García A, Adams AJ, Briggs CJ, Galina-Tessaro P, Valdez-Villavicencio JH, Hollingsworth BD, Shaffer HB, Fisher RN. 2018. Occurrence of *Batrachochytrium dendrobatidis* in anurans of the Mediterranean region of Baja California, México. *Diseases of Aquatic Organisms* 127: 193–200.

Peralta-García A, Hollingsworth BD, Richmond JQ, Valdez-Villavicencio JH, Ruiz-Campos G, Fisher RN, Cruz-Hernández P, Galina-Tessaro P. 2016. Status of the California Red-legged Frog (*Rana draytonii*) in the state of Baja California, México. *Herpetological Conservation and Biology* 11: 168–180.

Peralta-García A, Samaniego-Herrera A, Valdez-Villavicencio JH. 2007. Registros nuevos de reptiles en islas del Noroeste de México. *Acta Zoológica Mexicana* (*n.s.*) 23: 179–182.

Peralta-García A, Valdez-Villavicencio JH. 2004. *Ensatina eschscholtzii eschscholtzii*. Geographic distribution. *Herpetological Review* 35: 279.

Pereira HM, Leadley PW, Proenca V, Alkemade R, Scharlemann JPW, Fernandez-Manjarres JF, Araujo MB, Balvanera P, Biggs R, Cheung WWL, et al. 2010. Scenarios for global biodiversity in the 21st century. *Science* 330: 1,496–1,501.

Pianka EP. 1966. Convexity, desert lizards, and spatial heterogeneity. *Ecology* 47: 1,055–1,059.

Pliego-Sánchez JV, Blair C, Díaz de la Vega-Pérez AH, Jiménez-Arcos VH. 2021. The insular herpetofauna of Mexico: composition, conservation, and biogeographic patterns. *Ecology and Evolution* 2021: 1–14.

Ramírez-Bautista A, Hernández-Salinas U, Cruz-Elizalde R, Berriozabal-Islas C, Moreno-Lara I, DeSantis DL, Johnson JD, García-Padilla E, Mata-Silva V, Wilson LD. 2020. The herpetofauna of Hidalgo, Mexico: composition, distribution, and conservation status. *Amphibian & Reptile Conservation* 14(1) [General Section]: 63–118 (e224).

Rodríguez-Estrella R, Pérez-Navarro JJ, Granados B, Rivera L. 2010. The distribution of an invasive plant in a fragile ecosystem: the Rubber Vine (*Cryptostegia grandiflora*) in oases of the Baja California peninsula. *Biological Invasions* 12: 3,389–3,393.

Rodríguez-Revelo N, Espejel I, Jiménez-Orocio O, Martínez ML, Infante-Mata D, Monroy R. 2014a. Baja California. Pp. 146–156 In: *Diagnostico General de las Dunas Costeras de México*. Editors, Martínez ML, Moreno-Casasola P, Espejel I, Jiménez-Orocio O, Infante-Mata D, Rodríguez Revelo N, Cruz-González JC. SEMARNAT, México, DF, Mexico. 350 p.

Rodríguez-Revelo N, Espejel I, Jiménez-Orocio O, Martínez ML, Infante-Mata D, Monroy R. 2014b. Baja California Sur. Pp. 159–168 In: *Diagnostico General de las Dunas Costeras de México*. Editors, Martínez ML, Moreno-Casasola P, Espejel I, Jiménez-Orocio O, Infante-Mata D, Rodríguez Revelo N, Cruz-González JC. SEMARNAT, México, DF, Mexico. 350 p.

Romero-Schmidt H, Ortega-Rubio A, Arguelles-Méndez C, Coria-Benet R, Solís-Marin F. 1994. The effect of two years of livestock grazing exclosure upon abundance in a lizard community in Baja California

Sur, Mexico. *Bulletin of the Chicago Herpetological Society* 29: 245–248.

Romero-Schmidt HL, Ortega-Rubio A. 1999. Changes in lizard abundance on protected versus grazed desert scrub in Baja California Sur, Mexico. *Brazilian Archives of Biology and Technology* 42: 1–6.

Rorabaugh JC, Lemos-Espinal JA. 2016. *A Field Guide to the Amphibians and Reptiles of Sonora, Mexico*. ECO Herpetological Publishing and Distribution, Rodeo, New Mexico, USA. 688 p.

Rotem G, Ziv Y, Giladi I, Bouskila A. 2013. Wheat fields as an ecological trap for reptiles in a semiarid agroecosystem. *Biological Conservation* 167: 349–353.

Santamaría-del-Angel E, Alvarez-Borrego S, Müller-Karger FE. 1994. Gulf of California biogeographic regions based on coastal zone color scanner imagery. *Journal of Geophysical Research* 99: 7,411–7,414.

Santos-Barrera G, García A, Calzada-Arciniega RA, Pérez-Cervantes NC, Pacheco-Rodríguez J. 2021. Herpetofauna at risk of extinction: amphibians and reptiles in Mexico, critical areas, and conservation strategies. Pp. 275–288 In: *Imperiled: The Encyclopedia of Conservation*. Editors, DellaSala DA, Goldstein MI. Elsevier, Amsterdam, Netherlands. 2,608 p.

Schirmel J, Bundschuh M, Entling MH, Kowarik I, Buchholz S. 2016. Impacts of invasive plants on resident animals across ecosystems, taxa, and feeding types: a global assessment. *Global Change Biology* 22: 594–603.

Schloegel LM, Toledo LF, Longcore JE, Greenspan SE, Vieira CA, Lee M, Zhao S, Wangen SC, Ferreira CM, Hipolito M, et al. 2012. Novel, panzootic, and hybrid genotypes of amphibian chytridiomycosis associated with the bullfrog trade. *Molecular Ecology* 21: 5,162–5,177.

Schlesinger CA, Kaestli M, Christian KA, Muldoon S. 2020. Response of reptiles to weed-control and native plant restoration in an arid, grass-invaded landscape. *Global Ecology and Conservation* 24: e01325.

SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales). 2003. *Evaluación de la Degradación del Suelo Causada por el Hombre en la República Mexicana, Escala 1: 250 000. Memoria Nacional 2001-2002*. Semarnat y CP, México, DF, Mexico. 77 p.

SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales). 2010. Norma Oficial Mexicana nom-059-semarnat-2010, Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. *Diario Oficial de la Federación*, 30 de Diciembre de 2010. SEMARNAT, México, DF, Mexico.

SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales). 2019. Modificación del Anexo Normativo III, Lista de especies en riesgo de la Norma Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. *Diario Oficial de la Federación*, 14 de Noviembre de 2019. SEMARNAT, México, DF, Mexico.

Senko J, Koch V, Megill WM, Carthy RR, Templeton RP, Nichols WJ. 2010. Fine scale daily movements and habitat use of East Pacific Green Turtles at a shallow coastal lagoon in Baja California Sur, Mexico. *Journal of Experimental Marine Biology and Ecology* 391: 92–100.

Shreve F. 1951. Vegetation and flora of the Sonoran Desert. Volume 1. Vegetation. *Carnegie Institute of Washington Publications* 591: 1–192.

Shreve F, Wiggins IR. 1964. *Vegetation and Flora of the Sonoran Desert. 2 Volumes*. Stanford University Press, Stanford, California, USA. 1,752 p.

Sinervo B, Méndez-de la Cruz F, Miles DB, Heulin B, Bastiaans E, Villagrán-Santa Cruz M, Lara-Resendiz R, Martínez-Méndez N, Calderón-Espinosa MI, Meza-Lázaro RN, et al. 2010. Erosion of lizard diversity by climate change and altered thermal niches. *Science* 328: 894–899.

Skerratt LF, Berger L, Speare R, Cashins S, McDonald KR, Phillott AD, Hines HB, Kenyon N. 2007. Spread of chytridiomycosis has caused the rapid global decline and extinction of frogs. *EcoHealth* 4: 125–134.

Smalling KL, Rowe JC, Pearl CA, Iwanowicz LR, Givens CE, Anderson CW, McCreary B, Adams MJ. 2021. Monitoring wetland water quality related to livestock grazing in amphibian habitats. *Environmental Monitoring and Assessment* 193: 58.

Sokal RR, Michener CD. 1958. A statistical method for evaluating systematic relationships. *University of Kansas Science Bulletin* 38: 1,409–1,438.

Spencer JE, Pearthree PA. 2001. Headward erosion versus closed-basin spillover as alternative causes of Neogene capture of the ancestral Colorado River by the Gulf of California. Pp. 215–219 In: *The Colorado River: Origin and Evolution: Grand Canyon, Arizona. Grand Canyon Association Monograph 12*. Editors, Young RA, Spamer EE. Grand Canyon Association, Grand Canyon, Arizona, USA. 280 p.

Terán-Juárez SA, García-Padilla E, Mata-Silva V, Johnson JD, Wilson LD. 2016. The herpetofauna of Tamaulipas, Mexico: composition, distribution, and conservation. *Mesoamerican Herpetology* 3: 42–113.

Torres-Hernández LA, Ramírez-Bautista A, Cruz-Elizalde R, Hernández-Salinas U, Berriozabal-Islas C, DeSantis DL, Johnson JD, Rocha A, García-Padilla E, Mata-Silva V, et al. 2021. The herpetofauna of Veracruz, Mexico: composition, distribution, and conservation status. *Amphibian & Reptile*

Conservation 15(2) [General Section]: 72–155 (e285).

Troyo-Diéguez E, Cruz-Falcón A, Norzagaray-Campos M, Beltrán-Morales LF, Murillo-Amador B, Beltrán-Morales FA, García-Hernández JL, Valdez-Cepeda RD. 2010. Agotamiento hidro-agricola a partir de la revolucion verde: axtraccion de agua y gestion de la tecnologia de riego en Baja California Sur, México. *Estudios Sociales* 18: 178–201.

Ureta C, Cuervo-Robayo AP, Calixto-Pérez E. 2018. A first approach to evaluate the vulnerability of islands' vertebrates to climate change in Mexico. *Atmósfera* 31: 221–254.

Valdez-Villavicencio JH, Peralta-García A, Guillen-González JA. 2016. Nueva población de la tortuga de poza del suroeste *Emys pallida* en el Desierto Central de Baja California, México. *Revista Mexicana de Biodiversidad* 87: 264–266.

Valdez-Villavicencio JH, Peralta-García A, González-Gutiérrez NS, Hernández-Morlán XI, Hinojosa-Huerta O. 2021. Diversity of the herpetofauna in restored and disturbed sites in the Colorado River Delta, Baja California, Mexico. *Revista Mexicana de Biodiversidad* 92: e923763.

Valdez-Villavicencio JH, Peralta-García A, Galina-Tessaro P, Hollingsworth BD, Fisher RN. 2023. Distribution and conservation of the southwestern pond turtle *Actinemys pallida* in Baja California, México. Pp. 69–79 In: *Estudios Sobre la Biología y Conservación de las Tortugas en México*. *Revista Latinoamericana de Herpetología, Publicación Especial* #6. Editors, Macip-Ríos R, Flores-Villela O. Sociedad Herpetológica Mexicana, México, DF, Mexico. [In Press].

Valentine LE, Roberts B, Schwarzkopf L. 2007. Mechanisms driving avoidance of non-native plants by lizards. *Journal of Applied Ecology* 44: 228–237.

Vanderplank S, Ezcurra E, Delgadillo J, Felger R, McDade LA. 2014a. Conservation challenges in a threatened hotspot: agriculture and plant biodiversity losses in Baja California, Mexico. *Biodiversity and Conservation* 23: 2,173–2,182.

Vanderplank S, Wilder BT, Ezcurra E. 2014b. *Uncovering the Dryland Biodiversity of the Cabo Pulmo Region*. Botanical Research Institute of Texas and Next Generation Sonoran Desert Researchers, Fort Worth, Texas, USA. 107 p.

Van Devender T. 1990. Late Quaternary vegetation and climate of the Sonoran Desert, United States, and Mexico. Pp. 134–165 In: *Packrat Middens: The Last 40,000 Years of Biotic Change*. Editors, Betancourt JL, Van Devender TR, Martin PS. University of Arizona Press, Tucson, Arizona, USA. 478 p.

Wake DB. 1991. Declining amphibian populations. *Science* 253: 860.

Wiggins IL. 1980. *Flora of Baja California*. Stanford University Press, Stanford, California, USA. 1,025 p.

Wilson LD, Mata-Silva V, Johnson JD. 2013a. A conservation reassessment of the reptiles of Mexico based on the EVS measure. Contribution to Special Mexico Issue. *Amphibian & Reptile Conservation* 7(1): 1–47 (e61).

Wilson LD, Johnson JD, Mata-Silva V. 2013b. A conservation reassessment of the amphibians of Mexico based on the EVS measure. Contribution to Special Mexico Issue. *Amphibian & Reptile Conservation* 7(1): 97–127 (e69).

Wilson LD, Johnson JD, Porras LW, Mata-Silva V, Elí García-Padilla E. 2017. A system for categorizing the distribution of the Mesoamerican herpetofauna. *Mesoamerican Herpetology* 4: 901–913.

Wilson LD, McCranie JR. 2004. The conservation status of the herpetofauna of Honduras. *Amphibian & Reptile Conservation* 3(1): 6–33 (e12).

Woolrich-Piña GA, Ramírez-Silva JP, Loc-Barragán J, Ponce Campos P, Mata-Silva V, Johnson JD, García-Padilla E, Wilson LD. 2016. The herpetofauna of Nayarit, Mexico: composition, distribution, and conservation status. *Mesoamerican Herpetology* 3: 375–448.

Woolrich-Piña GA, García-Padilla E, DeSantis DL, Johnson JD, Mata-Silva V, Wilson LD. 2017. The herpetofauna of Puebla, Mexico: composition, distribution, and conservation status. *Mesoamerican Herpetology* 4: 790–884.

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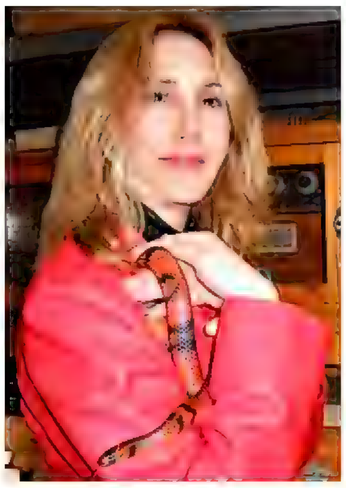
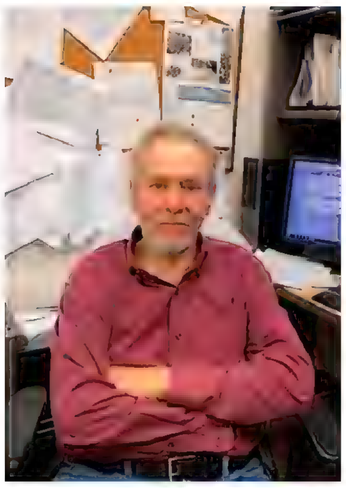
Jorge H. Valdez-Villavicencio was born in Ensenada, Baja California, Mexico. He obtained his Bachelor's degree at the Universidad Autónoma de Baja California (UABC), and his Master's degree in the use, management, and conservation of natural resources at the Centro de Investigaciones Biológicas del Noroeste in La Paz, Baja California Sur. He has collaborated on various projects related to the monitoring, research, and conservation of wildlife, mainly amphibians and reptiles in the Baja California peninsula. Jorge is an Associated Curator of the Herpetological Collection of the UABC, and the San Diego Natural History Museum. An author or co-author of several scientific papers, Jorge has participated in national and international scientific meetings, symposia, and workshops, and is a member of the two Mexican herpetological societies. Currently, he is the Research Coordinator and founding member of Fauna del Noroeste, a non-profit organization that seeks to promote local biodiversity conservation based on scientific research. His research interest is focused on the ecology and conservation of amphibians and reptiles.



Lydia Allison Fucsko, who resides in Melbourne, Australia, is an environmental activist and amphibian conservationist. As a photographer with international publications, she has taken countless amphibian photographs, including photo galleries of frogs mostly from southeastern Australia. Lydia has a Bachelor of Humanities from La Trobe University (Bundoora, Victoria, Australia), a Diploma in Education from the University of Melbourne (Parkville, Victoria, Australia), and postgraduate diplomas in computer education and in vocational education and training from the University of Melbourne (Parkville). Additionally, she has a Master's Degree in Counseling from Monash University (Clayton, Victoria, Australia). She received her Ph.D. on Environmental Education, which promoted habitat conservation, species perpetuation, and global sustainable management, from Swinburne University of Technology (Hawthorn, Victoria, Australia), while being mentored by the late Australian herpetologist and scholar Dr. Michael James Tyler (Order of Australia recipient). A sought-after educational consultant, Lydia has academic interests that include: clinical psychology, focusing on psychopathology; neuroscience and empathy; environmental education for sustainable development; sentient ecology; academic writing; and creative writing, which includes poetry and creative non-fiction books for children and young adults. Lydia is also the senior author (with Boria Sax) of a chapter in the 2019 *Springer Encyclopedia of Sustainability in Higher Education* entitled "Learning Activities for Environmental Education for Sustainable Development." Recently, she co-authored an obituary of Jaime D. Villa; a study of the introduced Mesoamerican herpetofauna; a treatment of conservation prospects of the Mesoamerican salamander fauna; papers on the herpetofaunas of Veracruz, Querétaro, and Guanajuato, Mexico; reviews of the books *Advances in Coralsnake Biology, with an Emphasis on South America and Lizards of Mexico. Part 1: Iguanian Lizards*; a study on the biological and cultural diversity of Oaxaca, Mexico; the description of a new species of snake named *Tantilla carolina* in honor of her mother Karolina Laszló; and a survey co-authored with Michael J. Tyler of calamities affecting museum collections around the world, among several other academic papers. In 2020, the species *Tantilla lydia*, with the suggested common name of Lydia's little snake, was named in her honor.

Bradford Hollingsworth has had a life-long interest in the diversity of amphibians and reptiles. His research focuses on the systematics and biogeography of amphibians and reptiles of the Southwest, including the Baja California peninsula and its associated islands. He is responsible for the care and maintenance of San Diego Natural History Museum's 78,000 amphibian and reptile research specimens, as the newly-established Laurence M. Klauber Curator of Herpetology, and launched the *Amphibian and Reptile Atlas of Peninsular California* to help make biodiversity information more accessible to the world. Bradford received his B.S. (1988) and M.S. (1995) degrees from San Diego State University, and his doctorate (1999) from Loma Linda University (Loma Linda, California, USA).



Jerry D. Johnson is Professor of Biological Sciences at The University of Texas at El Paso, and has extensive experience studying the herpetofauna of Mesoamerica, especially that of southern Mexico. Jerry is the Director of the 40,000-acre "Indio Mountains Research Station," was a co-editor on *Conservation of Mesoamerican Amphibians and Reptiles* and co-author of four of its chapters. He is also the senior author of the recent paper "A conservation reassessment of the Central American herpetofauna based on the EVS measure" and is Mesoamerica/Caribbean editor for Geographic Distribution section of *Herpetological Review*. Johnson has authored or co-authored over 130 peer-reviewed papers, including two notable articles in 2010, "Geographic distribution and conservation of the herpetofauna of southeastern Mexico" and "Distributional patterns of the herpetofauna of Mesoamerica, a Biodiversity Hotspot." One species, *Tantilla johnsoni*, has been named in his honor. Presently, he is an Associate Editor and Co-chair of the Taxonomic Board for the journal *Mesoamerican Herpetology.*

Vicente Mata-Silva is a herpetologist originally from Río Grande, Oaxaca, Mexico. His interests include the ecology, conservation, behavior, systematics, natural history, and biogeography of the herpetofaunas of Mexico, Central America, and the southwestern United States. He received his B.S. degree from the Universidad Nacional Autónoma de México (UNAM), and his M.S. and Ph.D. degrees from the University of Texas at El Paso (UTEP). Vicente is an Assistant Professor of Biological Sciences at UTEP in the Ecology and Evolutionary Biology Program, and Assistant Director of UTEP's 41,200-acre Indio Mountains Research Station, located in the Chihuahuan Desert of Trans-Pecos, Texas. To date, Vicente has authored or co-authored over 100 peer-reviewed scientific publications. He also is a Taxonomic Board Member of the website *Mesoamerican Herpetology* and Associate Editor for the journal *Herpetological Review.*

Arturo Rocha is a Ph.D. student in the Ecology and Evolutionary Biology program at the University of Texas at El Paso. His interests include the study of the biogeography, physiology, and ecology of amphibians and reptiles in the southwestern United States and Mexico. A graduate of the University of Texas at El Paso, his thesis centered on the spatial ecology of the Trans-Pecos Rat Snake (*Bogertophis subocularis*) in the northern Chihuahuan Desert. To date, he has authored or co-authored over 20 peer-reviewed scientific publications.

Dominic L. DeSantis is an Assistant Professor of Biology at Georgia College & State University, Milledgeville, Georgia, USA, in the Department of Biological and Environmental Sciences. Dominic's research interests broadly include the behavioral ecology, conservation biology, and natural history of herpetofauna. In addition to ongoing collaborative projects associated with the Mesoamerican Research Group, much of Dominic's current research focuses on using animal-borne sensor technologies to study the behavioral ecology of snakes in the field. While completing his Ph.D. at the University of Texas at El Paso, Dominic accompanied Vicente Mata-Silva, Elí García-Padilla, and Larry David Wilson on survey and collecting expeditions to Oaxaca in 2015, 2016, and 2017, and is a co-author on numerous natural history publications produced from those visits, including an invited book chapter on the conservation outlook for herpetofauna in the Sierra Madre del Sur of Oaxaca.

Louis W. Porras graduated with a degree in Biology in 1971 from what is known today as Miami-Dade College (Miami, Florida, USA). Over his career, Louis has authored or co-authored over 60 academic publications, including the descriptions of two new species, and two taxa have been named in his honor. Louis developed an interest in herpetology at an early age in his native Costa Rica. His passion for the field led him to travel to many remote areas, including throughout the Bahamas, the United States, Mesoamerica, and parts of South America. In 1968, he worked at the Houston Zoological Gardens, and from 1982 to 1984 at Utah's Hogle Zoo. In 1976, he attended the inaugural meeting of the International Herpetological Symposium (IHS), and later served the group as Vice-President and President. In 1993, along with Gordon W. Schuett, he helped launch the journal *Herpetological Natural History*, and for the IHS' 20th anniversary, in recognition of his contributions, three former Presidents dedicated the book *Advances in Herpetoculture* in his honor. Louis' career in publishing began in 1995, when as a member of Canyonlands Publishing Group, he helped publish *Fauna* magazine and the book *Pythons of Australia.* In 2002, he founded Eagle Mountain Publishing, LC, which has published such herpetological titles as *Biology of the Vipers* (2002), *Biology of the Boas and Pythons* (2007), *Amphibians, Reptiles, and Turtles in Kansas* (2010), *Conservation of Mesoamerican Amphibians and Reptiles* (2010), and *Amphibians and Reptiles of San Luis Potosí* (2013). From 2014 to 2018, he was the Publisher and Managing Editor of the journal *Mesoamerican Herpetology*, and more recently he was the Publisher and Co-editor of the book *Advances in Coralsnake Biology: with an Emphasis on South America.*

Larry David Wilson is a herpetologist with extensive experience in Mesoamerica (1966 to the present). He was born in Taylorville, Illinois, United States, and received his university education at the University of Illinois at Champaign-Urbana (B.S. degree, 1962) and at Louisiana State University in Baton Rouge (M.S. and Ph.D. degrees, 1965 and 1968, respectively). He has authored or co-authored 482 peer-reviewed papers and books on herpetology. Larry is the senior editor of *Conservation of Mesoamerican Amphibians and Reptiles* (2010) and the co-author of seven of its chapters. His other books, all co-authored, include *The Snakes of Honduras* (two editions, 1982 and 1985), *Middle American Herpetology* (1988), *The Amphibians of Honduras* (2002), *Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras* (2005), *The Amphibians and Reptiles of the Honduran Mosquitia* (2006), and *Guide to the Amphibians & Reptiles of Cusuco National Park, Honduras* (2008). He is also the co-author of 15 published entries in the Mexican Conservation Series dealing with the herpetofauna of the states of Michoacán, Oaxaca, Chiapas, Tamaulipas, Nayarit, Nuevo León, Jalisco, Puebla, Coahuila, Hidalgo, Veracruz, Querétaro, Tabasco, and Guanajuato, as well as the tri-state Mexican Yucatan Peninsula. In addition, Larry is a co-author of several significant publications on the development and extensive application of the EVS measure and on conservation issues related to the Mexican herpetofauna at the national level. To date, he has authored or co-authored the descriptions of 76 currently-recognized herpetofaunal species, and six species have been named in his honor, including the anuran *Craugastor lauraster*, the lizard *Norops wilsoni*, and the snakes *Oxybelis wilsoni*, *Myriopholis wilsoni*, and *Cerrophidion wilsoni*, as well as the coccidian parasite *Isospora wilsoni*. In 2005, he was designated a Distinguished Scholar in the Field of Herpetology at the Kendall Campus of Miami-Dade College by the then-campus president, Dr. Wasim Shomar. Currently, Larry is a Co-chair of the Taxonomic Board for the website *Mesoamerican Herpetology.*